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Session 1931-32

PART IV (pp. 73-150)

NOTICE

Non-Fellows may obtain the Proceedings for the current year, including each part for the Session as published, by prepayment of 10s. 6d. post-free.

After Capt. Dollman's reply to the various comments, the PRESIDENT expressed his great interest in Captain Dollman's communication and in the series of specimens exhibited. He referred to the importance of such detailed observations of seasonal changes in colour, and indicated that Captain Dollman's observations showed that colour varieties should not be established on single specimens, obtained at one season only.

An account of an expedition to the Island of Marajó at the mouth of the River Amazons. (Lecture.) By Mr. J. T. Cunningham.

MR. CUNNINGHAM gave a general account, illustrated by lantern-slides, of the expedition made by Mr. D. M. Reid, of the Biology Department, Harrow School, and himself to the Island of Marajó at the mouth of the River Amazons. The special object of the expedition was to carry out experiments on living specimens of *Lepidosiren paradoxa*, in order to decide whether the vascular filaments developed on the pelvic limbs of the male during the breeding season actually give off oxygen to the surrounding water when the latter contains a very small proportion of oxygen in solution. The results of the experiments proved that oxygen was given off, and the experiments and results are described in detail in a paper which has been communicated to the Royal Society.

Mr. Cunningham then proceeded with his narrative as follows:—

We left Liverpool on 18 November 1930, and arrived on 19 December at Fazenda Camburupý, the house of a cattle range in the Island of Marajó. At this time the dry season had not come to an end; the first rain of the wet season fell on 21 December, but for some days after this there were only occasional light showers. Every effort was made to obtain *Lepidosiren* in the neighbourhood, either in the branches of the small rivers (igarapés) or in burrows in which the fish might be hidden during the dry season in the dried-up swamps.

We therefore proceeded to Fazenda Dunas on the north coast of Marajó, a place where Dr. Emil Goeldi, founder and for some years Director of the Museum at Pará, had obtained three specimens of *Lepidosiren* in 1897 and 1898 (Proc. Zool. Soc. 1898). We arrived there by sailing-boat on 16 January. The house of Dunas stands near the north shore of Marajó on the east side of a small igarapé which opens into the sea some distance west of the house. We were able to carry out our experimental work in one of the enclosed compartments of the space below the house, which, as usual on Marajó, is built on pillars, in this case of wood. The region of the fazenda naturally divides itself into three

portions, of which the natural features are in strong contrast, namely, (1) the shore, consisting of a vast extent of white sand with a very gradual slope, (2) the igarapé, with several branches or tributaries, and bordered on each side with dense vegetation of trees and bush, (3) the swamp-pastures, covered with a varying depth of water which was continually increasing during the period of our stay.

We identified the Rego de Jacaré magro, which is mentioned by Goeldi as the igarapé near which his specimens of *Lepidosiren* were taken, and we made frequent ascents of this igarapé in dug-out canoes, and searched the neighbouring swampy ground for *Lepidosiren* and its burrows, but very few specimens were obtained within the boundaries of the fazenda. We offered to pay a considerable price for specimens, and ultimately received specimens about once a week from men who lived at a place called Bonito, about eighteen hours' journey west of Dunas. We were informed that they were obtained by finding the nest-burrows in the mud at the bottom of the swamp at a depth of two or three feet of water. In one case a reed about eight feet long was brought to show the length of the burrow which had been opened out. Both males and females were received from Bonito. At first the males had only short incipient filaments, but in March specimens with longer filaments were obtained up to a maximum of 22 mm. We also received nests with eggs alive and developing, but we had no time, and it was not our purpose, to study the development of the embryo.

The fauna both at Camburupý and at Dunas was extremely abundant and interesting, and we had excellent opportunities to make observations on habits and habitats. One of the most interesting and abundant forms among the fishes was the four-eyed fish *Anableps tetrophthalmus*, which swims with its protruding eyes half out of water, and in relation to this habit has each eye divided horizontally by a band of pigment across the cornea, and the pupil and lens also divided into an upper and lower half, one adapted to vision in air, the other to vision in water. We were surprised to find this fish swimming on the open shore between the breaking waves when the tide was rising, and at the smooth surface of the extensive shallow tidal pools when the tide was out.

A vote of thanks to Mr. Cunningham concluded the meeting.

4 FEBRUARY 1932

Professor F. E. WEISS, F.R.S., President,
in the Chair

The Proceedings of the General Meeting held on Thursday, 21 January 1932, having been circulated, were taken as read and confirmed.

A list of names of those who had made gifts to the Library since the previous meeting was read and laid on the table.

The following Fellows signed the Obligation in the Book of the Charter and Bye-Laws and were admitted:—Hugh Charles Sampson, John Scott Lennox Gilmour, and Edmund William Mason.

Certificates of recommendation of the following candidates for Fellowship were read:—For the first time, in favour of George Taylor, Robert Moyes Adam, Mary Ethelwyn Millner, Norman Woodhead, and Robert Wilfred Inder.

The PRESIDENT announced that a notification had been received that the 12th International Congress of Zoology will be held at Lisbon in the summer of 1935.

The PRESIDENT announced that there is a vacancy in the list of Associates by the death of Andrew Scott.

The PRESIDENT referred to a letter he had received from Professor C. E. CORRENS, F.M.L.S., with reference to the specimens of yellow-flowered privet exhibited at the General Meeting of the 22 October 1931.

Further notes on the genera *Fumaria* and *Rupicapnos*.—II. By Mr. H. W. Pugsley.

MR. PUGSLEY spoke of the nature of his further notes on the genera *Fumaria* and *Rupicapnos* and traced the progress of the knowledge of these groups since the publication of Olof Hammar's monograph in 1854. Most of the forms now described were collected in the recent Moroccan expeditions of the French botanists, and particularly by Prof. René Maire, of Algiers. It has been found that, while *Fumaria* species abound in Morocco as far south as the Anti-Atlas, the genus *Rupicapnos* is confined to the north of the country, and does not reach the Middle or the Great Atlas.

Attention was drawn to the prevalent occurrence of *Fumariae* in natural habitats in North Africa and elsewhere in the Mediterranean region, and lantern-slides of a number of stations of this kind on the coast of Southern Dalmatia and the adjacent islands were exhibited. The salient features of the general phanerogamic vegetation of coastal Dalmatia were touched upon and contrasted with those prevailing around Sarajevo, in the interior of Bosnia.

The PRESIDENT expressed the thanks of the meeting to the author.

Exhibit of the algal epiphyte, *Phaeothamnion*.**By Miss M. Godward, B.Sc. (Visitor).**

LIVING specimens were exhibited of *Phaeothamnion* from a pond in Epping Forest, where they occurred as epiphytes on water-plants. Attention was drawn to the fact that the specimens resembled more closely the form described by Pascher as *Phaeothamnion polychrysis*.

Prof. F. E. FRITSCH pointed out that the discovery of *Phaeothamnion* as a not infrequent epiphyte in the ponds of the Epping Forest region was of interest, because it showed that one had only to examine a little-explored habitat to find that forms hitherto regarded as rare were commoner than had been supposed. The same result had been obtained in investigating the growths on the stones of river-beds, where not only a number of rare forms, but also a considerable number of new ones, even including new genera of algae, had come to light. *Phaeothamnion* was the only filamentous member of Chrysophyceae so far found in this country, although others were known on the Continent. Its true systematic position had long been in doubt, but Pascher had definitely established that it belonged to the class Chrysophyceae.

Dr. E. J. COLLINS asked upon what aquatic form the epiphytic *Phaeothamnion* was found growing and whether it grew upon this form exclusively or predominantly.

The fungus-stone, *Polyporus tuberaster*.**By Mr. J. Ramsbottom, O.B.E., Sec.L.S.**

ONE of the photographs shown by the President at our last meeting reminded me of a fungus which I thought, perhaps, sufficiently curious to bring to the notice of the Society.

Since the earliest times there are references to a stone which, on being watered, gives rise to a mushroom. There are hints of it in many writers, and it is said to be mentioned by Strabo in 50 B.C. It appears to have had some connection with the mysteries of the Lynx, and was regarded as the coagulated urine of wolves to be found on the summits of high mountains. This idea is to be found seriously argued in the writings of the Renaissance period.

The stone, as a matter of fact, is a mixture of rock, earth, and pebbles bound together or permeated by the mycelium of the fungus *Polyporus tuberaster*. Biologically the fungus mycelium acts as a sclerotium, but morphologically the structure differs from a sclerotium in that it is not composed wholly of fungus; in other words, it may be regarded as a sclerotium which is interspersed with foreign material. The

stone may be of different sizes and composition, occasionally weighing as much as fifty pounds. The fruit-body is esculent, and at one time was held in such merit that it appeared on the tables of popes, kings, and dukes. It has gradually become more scarce, and this Mattiolo ascribes to the disappearance of woodlands. Such a strange phenomenon naturally aroused interest, and the explanations were almost as wonderful as the facts.

The classical locality for the *Pietra fungiea* is around Naples. It was from this neighbourhood that it was described or mentioned by Barbarus in 1534, Mattioli 1563, Caesalpinus 1583, Porta 1591, Caspar Bauhin 1623, Ferrari 1646, J. Bauhin 1650, Imperato 1672, Boccone 1697, and probably others.

In 1649 Marcus Aurelius Severinus wrote a thesis, 'De lapide fungifero &c.', though this is known chiefly in Brueckmann's edition of 1728. He discusses at length the question whether the stone arises from wolf's urine or whether it is analogous to truffles.

In 1729 Micheli clearly showed the nature of the *pietra funghi*, and has an annotated figure of a section of it, indicating the fungus.

Before this time Samuel Pepys much desired a specimen, as is seen from the following extracts from his correspondence :—

'Had I known Mr. Jackson had been so generall a virtuoso as I find he is, and a lover and collector of such curiosities as I find mentioned in the inventory of things sent in boxes from Naples, I should have minded him of the *lapis fungifer*, or the stone which produces mushrooms, which is to be had at Naples and no where else as ever I could heare of. I am sure he can have been in no place but all learned and ingenious persons who have been made happy with his acquaintance will be very ambitious of his corispondence, which I doubt not but he hath settled with them, and particularly with those of Naples. And if you please by your first to him to desire him to send thither for some of the *lapis fungifer* or mushroom stones, to be sent by the first shipping for England, you will oblige me and, if they come, I know they will gratify both yours and Mr. Jackson's curiosity.

'Capt. Hatton. Sept. 28. 1700.'

'I am ashamed to think of the disappointment you will meet with about my cargo of Lazarolles *, which will prove to be but one single one that I putt-up at Naples, as the first

* Medlars. Compare also: 'I am so unacquainted with Lazarolles as not to know how to prize my disappointment about them, only to find Captain Hatton (who continues his respects to you) looks upon them as a curiosity, and upon the *lapis fungifer* too. S.P. Dec. 3. 1700.'

I had then seen ; but since they have been more familiarized to me, in France, etc., I will consider what may be done as to Captain Hatton's proposal of sending to Naples for young-trees of them ; as also for the *lapis fungifer*.

'John Jackson. $\frac{5}{16}$. 1700.'

'Your friends (and particularly my self) are, I bless God, in perfect health here, excepting onely my excellent friend Sir James Houblon (who yet is at this time better) and Mr. Hatton, from whom I am specially to note to you the content he owns his having had in his perusall of your collections for me ; adding (to give it you in his own words) that had he known so much of your virtuosoship as he sayes he now does, he should have minded you of one thing which he is sorry to find unmentioned by you, viz., the *lapis fungifer* or stone that produces mushromes, which is to be had at Naples, and no where else that he knows of ; wishing that you would yet send to your correspondent there (for he depends upon your having provided yourself of one) for some of them, as what would be a welcome rarity to your self and friends here.

'S. Pepys. Oct. 8. 1700.'

John Hill in 1758 published 'An account of a stone in the possession of the Right Honourable the Earl of Stafford ; which on being watered produces excellent Mushrooms'. He states that the Italian naturalists describe a coarse and loose kind of stone which retains always the quality of affording mushrooms when watered, and that they have passed into writings of other nations as *Lapis fungifer* and the Mushroom-Stone. The stone he described was in the possession of Lady Stafford (in spite of the typical Hillian dedication to the Earl of Stafford). Hill says that when broken it had 'somewhat of the appearance of those coarse granites, which we call, from the place where they are found, Guernsey pebbles, and with which the streets of London are paved'. He performed the 'experiments by which stones are usually tried' and found that part of the mass was mineral, 'but as part of the mass burns away, that is plainly not of a stony nature ; and its smell while burning shews that it is not bituminous : we are therefore to look for it in the vegetable kingdom ; and from this part alone we shall find the mushrooms produced from the stone arise. . . . What the unassisted eye thus discovers, a microscope perfectly explains to us'. He compares the 'roots' of the mushroom to those of lignicolous species which occur year after year on the same trunk, and instances an example of the Beefsteak fungus on ash (an unusual host) and 'for many years an annual fungus of vast size, and of a very peculiar form, from the block of a smith's anvil in the Hay-market'.

He records it as occurring in the mountainous parts of Italy toward Piedmont; and also in Sicily and some other places. He names the fungus:—

‘*Boletus stipitatus radice perenni, pileo depresso scabro, poris subangulatis.*’

Hill thus confirms Micheli’s account, but he has his own figure—a different procedure from that which he adopted in his ‘Natural History of Plants’ (1751), where he copied all Micheli’s figures without acknowledgement.

In his ‘Museum Britannicum’ (1791) Rymdsdyk has a footnote to his account of ‘The Sallad Earthen Vessel, and the Scythian Lamb’.

‘It is but lately I found out by accident that they have likewise at the British Museum, a *mushroom-stone*, a kind of *Fossil*, extremely curious, for laying it in the earth, and a little earth on the top, then wetting it with water, *mushrooms* will shoot up in a short time. As to the germination and fructification, this is chiefly caused by the salt, &c., which renders land fertile, as may be seen of all manner of fruits, &c. planted in those salt marshes which flourish exceedingly, for those salts working with contrary salts in the seeds, exalt the principles of motion and vegetation, or as the poet says,

“All things exist by elemental strife”—POPE.’

The suggestions that have held sway in most writings are either that the stone is a truffle-like fungus on which the *Polyporus* is parasitic or that the fungus in the stone is the ‘root’ of the *Polyporus*. This is the same problem that perplexed the older mycologists about the nature of the sclerotium.

Gasparinni in 1841 still thought the stone itself to be a separate fungus, and called it *Mycelithe fungifera*.

The ‘Tuckahoe’ of N. America (*Grifeola* (*Polyporus*) *Tuckahoe* Güssow) is probably the same fungus. That of S. America, *Pachyma Cocos*, is a *Poria*.

The PRESIDENT expressed to Mr. Ramsbottom the thanks of the meeting.

Conceptions of phylogeny in the genus *Oenothera*.

By Professor R. Ruggles Gates, F.R.S.

THE genus *Oenothera* has a longer genetic history than any other plant. De Vries began his work with *O. Lamarckiana* in the ‘eighties, and the publication of his great work, ‘The Mutation Theory’, was begun in 1901. In 1905, study of the chromosomes in the mutants, and a decade later the main mutations with aberrant chromosome numbers, including

trisomics, tetraploids, and triploids, had been worked out (Gates, 'Mutation Factor in Evolution', 1915). Important as these types of change are in the evolution of other genera, they do not survive in *Oenothera*, where all the wild species have fourteen chromosomes.

It is now known that many *Oenothera* species and hybrids breed true because of catenation (linkage) of their chromosomes in meiosis. Investigation of this subject has become increasingly active during the last decade. Following the work of de Vries on twin hybrids, it has been shown that many species produce two kinds of gametes. Renner called these complexes, and gave them names. Thus the phenotype *O. Lamarckiana* is a combination of the complexes *gaudens* and *velans*. By extensive series of species-crosses the relationships between their complexes is being worked out. A few species, such as *O. Hookeri*, are homozygous, and have seven free pairs of chromosomes in meiosis, but the great bulk of species show more or less complete catenation, and as a result produce only two kinds of gametes. Frequently one pollen complex and the other egg complex are non-viable, or both types may be viable in both sexes, as in *Lamarckiana*. That catenation can arise from crosses between homozygous *Oenotheras* with seven free pairs of chromosomes has recently been shown experimentally.

Another fact of importance, shown by extensive investigations on the inheritance of flower-size, is that small flowers are usually dominant to large in species-crosses. Based on these and other lines of evidence, including distribution, the following conceptions regarding the phylogeny of the genus are developed :—

(1) The subgenus *Onagra* probably arose in Central America from the large-flowered subgenus *Euoenothera*.

(2) The large-flowered *Onagra* forms began to move northwards following the retreat of the ice in North America.

(3) In doing so they gave rise, through series of dominant parallel mutations, to progressively smaller flowered species, and at the same time hybridization between different specific types gave rise to further new species which bred true because of the chromosome catenation during meiosis which occurred in the crosses.

(4) Another series of parallel mutations gave rise to the various species and varieties with cruciate petals.

(5) In this way have arisen the more northerly small-flowered species with a high degree of catenation of their fourteen chromosomes.

(6) In the meantime much specific differentiation has also taken place through the accumulation of gene mutations, whose separate inheritance is usually obscured because

they belong to a complex, i.e. occur in linked chromosomes. Such gene mutations are exemplified by *rubricalyx*, *brevistylis*, and *nanella*.

(7) Segmental interchange of chromosomes has played a minor rôle in the evolution of the genus, chiefly in the direction of reducing the amount of catenation, and so producing more or less completely homozygous forms. An example is *O. Lamarckiana* ($(\textcircled{12})+1$ pair) $\longrightarrow$ *rubrinervis* ($(\textcircled{6})+4$ pairs) $\longrightarrow$ *deserens* (7 pairs).

(8) The heterozygous species, composed of two complexes and with a high degree of hybrid vigour, have a great advantage in the struggle for existence, and so the catenation has tended to increase to a maximum in the phylogeny of the genus; while more homozygous forms arising from them through segmental interchange, having less vigour, tend to be extinguished in competition.

The PRESIDENT moved the thanks of the Society to Prof. Gates for his very interesting communication. He desired to ask Prof. Gates, however, whether any observations existed as to the cross-pollination of *Oenothera* in nature. Obviously Prof. Gates's conclusions depended on an active hybridization by natural means.

Dr. E. J. COLLINS expressed personal thanks to Prof. Gates for the résumé dealing with the principal problems concerned in the phylogeny of the *Oenotheras*. He recalled the close study which Bateson had given to Renner's theory, a theory which involved the assumption of the formation at meiosis of definite viable chromosome complexes. This theory Bateson considered a great step forward in the elucidation of the complicated and elusive problem of inheritance in this genus, and Prof. Gates by his well-known researches had contributed in no small measure to the cytological confirmation of these results.

As one of the possible factors in the problem of the evolution of species, Dr. Collins concurred in the general importance of polyploidy, duplicate, differential or other, but he would like to hear the views of cytologists on the question in regard to a genus where there was a constant number of chromosomes throughout the whole run of species contained in it. Considerable work could be undertaken, he thought, with advantage on the genus *Lilium*, whose chromosomes in size and form seemed to offer a fair opportunity to the cytologist who desired to work on a group where polyploidy apparently did not exist. Generally, so far as he could see, no clear conception of the origin of species from the incidence of polyploidy, to which all could subscribe, had yet crystallized out.

Dr. F. W. SANSOME questioned the value of the analysis of the phylogeny of *Oenothera* species, and suggested that the phylogeny of the Renner 'complexes' was more important.

Sir SIDNEY HARMER enquired whether Professor Gates intended his statement that the homozygous condition is restricted to a single species to apply to the entire genus *Oenothera* or merely to the group of forms which have been specially studied by cytologists. He suggested that if the greater vigour of hybrids, associated with linkage of the chromosomes, were important in evolution, it might be anticipated that a large proportion of existing species, not merely in the genus *Oenothera*, would have linked or catenated chromosomes.

In his reply, Professor GATES emphasized the point of view that the relative importance of different evolutionary factors varied from one group of plants or animals to another. For example, polyploidy, which is of widespread occurrence in the phylogeny of Angiosperms, was apparently of very little significance in animals; and hybridization, which is an important condition in the phylogeny of some plant genera, might be negligible or non-existent in some groups of animals.

He stated that natural crossing took place more frequently in the large-flowered species, which usually required insect visits for an abundant production of seeds, whereas the small-flowered species had usually a short style and were normally self-pollinated in the bud. Nevertheless, even these species would undergo crossing when grown together in an experimental garden. His conception was that the greater amount of crossing, especially between widely different forms, had taken place in the earlier phylogeny of the genus, when the species had larger flowers and were moving northwards, spreading out and coming into contact with each other.

While polyploidy is a widespread condition in Angiosperms, yet it was not surprising to find genera, such as *Lilium* and *Carex*, in which species with chromosome multiples apparently do not occur. As polyploidy is only one means of differentiation, there is no reason why it should not be suspended in certain genera. It has recently been shown, however, that *Lilium tigrinum* is a triploid species.

O. Hookeri is the only *Oenothera* species at present known to be homozygous with seven free pairs of chromosomes. Catenation of chromosomes had recently been discovered in a number of other genera, usually on a smaller scale, and *Oenothera* was, therefore, not unique in this respect. The genus had, however, specialized in chromosome linkage, and this condition had probably arisen early in the phylogeny of the genus, beginning with segmental interchange of certain chromosomes.

Regarding Dr. Sansome's remark, it was pointed out that the aim of the work was an analysis of the relationships between the different complexes, and so between the various phenotypes (species) involved.

A vote of thanks to Professor Gates concluded the meeting.

18 FEBRUARY 1932

Professor F. E. WEISS, F.R.S., President,
in the Chair

The Proceedings of the General Meeting held on Thursday, 4 February 1932, having been circulated, were taken as read and confirmed.

A list of names of those who had made gifts to the Library since the previous meeting was read and laid on the table.

The following Fellows signed the Obligation in the Book of the Charter and Bye-Laws and were admitted :—Jessie Leese and Percival Sydney Jewell.

Certificates of recommendation of the following candidates for Fellowship were read :—For the second time, in favour of George Taylor, Robert Moyes Adam, Mary Ethelwyn Millner, Norman Woodhead, and Robert Wilfred Inder.

**Bequest of Smithiana from Dr. Francis Pierrepont Barnard.
By the President (Professor F. E. Weiss).**

AN interesting bequest has been received from the late Dr. FRANCIS PIERREPONT BARNARD, the great-grandnephew of Sir James Edward Smith, F.R.S., one of the founders and the first President of this Society. The items forming this bequest have been forwarded to us by Mrs. Ella Pierrepont Barnard, to whom the Council has already sent a resolution conveying its thanks and appreciation.

The bequest comprises the following items :—

(1) Sir James Edward Smith's own seal,—an agate engraved with a knight's helmet and the initials 'J.E.S.'; (2) Seven portraits of Sir James Edward Smith, of which five are engravings, one an etching already in the Society's collections, and the seventh an original drawing in chalks by Mrs. A. L. Lane, the wife of William Lane, a well-known portrait-painter and draughtsman. This original portrait of Smith as a young man is a valuable addition to the portraits possessed by the Society; (3) A small beautifully made cabinet that belonged to Sir James Edward Smith, and which contains his collection

of impressions of seals. This collection (some specimens from which were exhibited on the table) amounts to 538 impressions, partly collected by Smith and partly added by Dr. Francis Barnard. It is of particular interest to this Society, because it is obvious that the bulk of those collected by Smith came from the wrappers of letters addressed to Linnaeus and other contemporary naturalists; so that, in a minor way, this bequest makes an addition to the Linnaean Collections.

It may be of interest to mention a few of the celebrated men whose seals are represented in this collection. There are impressions of three different seals used by Linnaeus; the same applies to Solander. The younger Linnaeus's seal is also present. In addition, the seals of Haller, Jacquin, the de Jussieu, Jan Burman, John Ellis, Sir Joseph Banks, Alexander Garden, Stephen Hales, A. B. Lambert, Pennant, Dr. Richardson, Lettsom, John Mitchell, C. A. Agardh, Swartz, Masson, John Hope, Chantrey the sculptor, Hogarth the painter, and J. J. Rousseau are represented.

Dr. Francis Pierrepont Barnard was a Fellow of the Society of Antiquaries, well known for his works on numismatics and heraldry, his chief work being entitled 'The Casting Counter and the Counting Board', published in 1916. He was also the author of a well-known handbook on Mediaeval England.

Dr. A. B. RENDLE expressed the hope that a list of the impressions of seals would be published in the 'Proceedings'. The President replied that such a list would be published, probably at a later date.

Exhibit of specimens of *Protosiphon* from Egypt.

By Professor F. E. Fritsch.

PROFESSOR FRITSCH demonstrated living specimens of the rare siphonous alga *Protosiphon* which had been grown by moistening dried desert-silt received from Professor Oliver from Egypt. After drawing attention to the interest of the alga as a possible primitive member of the Siphonales connecting them with Chlorococcales, the speaker read an extract from a letter of Prof. Oliver describing the occurrence of the alga in Egypt. 'The material sent is just the upper crust of solidified desert-silt which is brought in great quantities on to the ground of the Faculty of Science by flood-water from heavy showers in the adjacent desert. Numerous organisms gradually make their appearance at the surface during the following weeks and, if slabs of mud are kept under shades so as to reduce evaporation, there are additional ones. Among this population are seedlings of higher plants, moss protonemata, and eventually moss plants, sundry algae

and fungi, including yeasts. The first plants to break the surface are *Protosiphon* and *Botrydium*, the former in tufts, the latter more usually in solitary specimens. These algae appear only where the mud is sheltered from the midday sun. Evidently the desert is snowed under with their resting spores. Knowing something of the desert I have a high respect for the drought-resisting qualities of these plants.' Prof. Fritsch drew attention to the small size of the specimens shown, which might, perhaps, be attributed to the unfavourable conditions for growth in a London laboratory.

The PRESIDENT, after conveying the thanks of the meeting to Professors Fritsch and Oliver, commented on the exhibit.

In reply, Professor FRITSCH stated that *Botrychium* usually occurred on damp mud left by receding water, and that, when the mud dried, the algae formed resting spores and vanished.

The BOTANICAL SECRETARY then read

**A note on an abnormal form of root in the scarlet runner bean.
By Miss Jean Dickson (Visitor).**

IN clearing ground in November 1931 roots of scarlet runner bean (*Phaseolus multiflorus*) were seen to have an unusual appearance. The plants were growing in soil which was extremely poor and rubbly except for the surface layer. They had been attacked by slugs soon after planting, but the surviving plants had shown abundant vegetative growth, with few flowers and fruit. The aerial parts were frosted and died back in late autumn. The main root had developed into a large swollen tuber, four to six inches long and two inches wide in the thickest portion, much like an Umbellifer root, but with texture similar to that of a *Dahlia* tuber. There were from six to eight well-developed lateral roots on the upper part of the tap-root, some showing a tendency to become swollen above; the lower part bore scattered under-developed laterals. There were remarkably few root-nodules, which were confined to the laterals nearest the surface of the soil. The epicotyledonary region bore numerous fine adventitious roots which also occasionally had nodules on their upper parts. At the base were two lateral buds which probably had arisen in the axils of the cotyledons. One specimen was almost spherical. Sections from the larger laterals and main root showed starch in the xylem parenchyma, which was more developed than in normal roots; there was also a small amount of starch in the cortex. Millon's reagent showed faint traces of protein in the external layer, being most marked just below the epidermis. No oil was found. The tuberized roots recall those described by Tincker, produced by submitting them to short periods of daylight.

Dr. M. A. H. TINCKER stated that *Phaseolus multiflorus*, like other species of the genus, is of Mexican origin; there it is an herbaceous perennial with tuberous roots. Grown under the long days of a northern European summer, the roots rarely thicken before the autumnal frosts, to which this plant is very susceptible. When grown under short periods of light of twelve hours' duration, the upward growth is checked, and the rate at which food-products accumulate in the roots is increased; such tuberous roots will produce new stems and leaves in the following spring if they are lifted and kept free from frost during the winter.

It appears unlikely that edaphic factors greatly modify the form of the roots, as these thickened roots have been produced in different soil composts (lower Silurian grits and Bagshot sand), and in 'sand cultures', to which the salts added were controlled. The starch was translocated to the roots both with and without a ready supply of potassium (sodium was substituted).

The process of accumulation is an expression of the difference between the rate of starch manufactured and the rate of utilization of the carbohydrates in growth, governed by the period of light.

The PRESIDENT having conveyed the thanks of the meeting to Miss Dickson and to the Botanical Secretary for reading the paper, made some additional comments.

Development of auricular 'glandular' patches in the Waterbucks. By Capt. Guy Dollman.

CAPTAIN GUY DOLLMAN exhibited some specimens of heads of Waterbucks to illustrate the development of subauricular patches in the genus *Kobus*. The following observations were made during the exhibition:—

We are familiar with the occurrence of curious, more or less circular, naked patches situated just below the insertion of the ear in two types of antelope, the Reedbucks and Oribis of the genera *Redunca* and *Ourebia* respectively. The former are members of the subfamily Reduncinae and the Oribis belong to a group of small antelopes known as the Neotraginae. In both these genera these naked patches are almost always developed, there being only a single case on record of their absence in *Ourebia*, and two cases in which they are not developed in the Reedbucks. The patches are not glandular, and their function appears to be quite unknown.

Formerly the various genera of the subfamily Reduncinae were divided into two groups, those species with bare subauricular patches forming the first group and containing only the Reedbucks (*Redunca*), and those without subauricular patches constituting the second group and containing the

genera *Pelea* (the Vaal Rhebok), *Kobus* (the Waterbucks), *Onotragus* (the Lechwes) and *Adenota* (the Kobs).

Recently my attention was drawn to two specimens of Waterbuck, brought back from East Central Africa by the Hon. Masauji Hachisuka, in which bare subauricular patches, of varying size, were developed. These patches do not appear to be so well defined as in the Oribis and Reedbucks, but that they are structurally the same seems probable. Messrs. Edward Gerrard & Son examined their extensive stock and found four specimens in which this character was developed, and two of them I have here this evening. A detailed search through the collection of the Natural History Museum failed to produce any further instances of this peculiarity, but Messrs. Rowland Ward have provided me with a whole mounted specimen in which a bare patch is developed on one side only.

In some of the specimens I have referred to the patches are very unequal in size and do not appear nearly so uniform as they do in the Oribis and Reedbucks. In the Oribis these patches are either circular or roughly triangular in shape, and never exceed about three-quarters of an inch in diameter. In the Reedbucks they are rather larger, but are usually circular and do not spread over the side of the neck as irregular areas of naked skin. In no other genus of Antelopes except *Ourebia*, *Redunca* and *Kobus* have any traces of bare subauricular patches been discovered.

Mr. M. A. C. HINTON said that, with the help of his son, he had made a microscopical examination of portions of the skin from the subauricular patches. The sections showed merely horny stratified epithelium such as one commonly saw in callosities or corns, and there was no trace of any special glandular structure. He was inclined to regard the bare patches as the result of mechanical abrasion; the habit of scratching just behind the ears with the sharp hoofs of the hind-feet might be the real cause of these curious features.

Mr. R. H. BURNE asked whether anything was known of the position assumed by the feet during sleep, and suggested that the bare areas behind the ears might be due to the friction and pressure of the hoofs in this or some other habitual attitude.

Mr. J. T. CUNNINGHAM suggested that the callosities or dermal cornifications might be due to friction with the horn of an opponent in fighting, not necessarily to blows on the skin with the point of the horn, but to pushing and rubbing with the side of the horn of the adversary.

**Scorpions collected by Mr. Bertram Thomas in Arabia.
By Dr. Susan Finnegan.**

Six species were represented in Mr. Bertram Thomas's collection of Scorpions from Arabia. Of these, one was a new species, and is the type of a new genus, belonging to the family Buthidae. In this form the tarsal spur is reduced to a small, weak spine, and is sometimes present on the fourth pair of legs and always absent from the third pair. Although this spine is of phylogenetic interest, it is doubtful whether the separation of the Buthidae into two subfamilies on this character alone is justifiable. The first three segments of the tail-region are flattened, the second segment having pronounced wing-like lateral expansions. This genus is nearly related to *Plesiobuthus*, described by Mr. Pocock in 1900 from Baluchistan.

Dr. CALMAN pointed out that the discovery of a new genus in a group so well known as the Scorpions was a matter of some general interest. The differences separating it from existing genera might appear trivial, but some of them affected characters such as the tibial spur, which had persisted since the Silurian epoch. He also called attention to the zoogeographical interest of the collections brought by Mr. Bertram Thomas from the hitherto unexplored regions of South-Eastern Arabia.

**The Diatomaceae (recent and fossil) of the district of the
Tay Estuary. By Dr. David McCall. (Communicated by
Prof. F. E. Fritsch.)**

THE paper for publication is a systematic report on the Diatomaceae of the Tay district from Carnoustie westwards to Glencarse, and from the Sidlaw Hills to the north of Fifeshire—an area of about 250 sq. miles; the neritic and plankton forms of the Firth of Tay are also dealt with. Since the district includes sea-coast, sandy shore, sand-dunes, meadow lanes, and uplands, the diatom flora is both rich and varied. Marine, brackish, lowland freshwater, sub-alpine, and alpine species are all well represented. Over nine hundred forms (species and varieties) are recorded, and these include a number of new records for Britain, and a number of new species and varieties. The diatoms of the Sidlaw Hills and adjacent country are particularly interesting, as here are found such 'relicta' forms as *Navicula gibbula* Cleve and *N. Semen* Ehrenb.

Up to 1924 *N. gibbula* had not been found south of the Polar Circle, but in that year Hustedt recorded it from the

Sarek Mountains and from the south of Finland, where he considered it to be a glacial relic. *N. Semen*, usually found in the fossil state, has previously been found in the living state in the Harz, where it is considered to be a survival from the post-glacial epoch. Both these diatoms occur in the living state on the Sidlaw Hills and in the surrounding country. As the Tay district affords ample evidence of severe glaciation in the moulding of the hills and in the deposits of boulder clays, sands, and gravels, the occurrence of these 'relicta' forms is of interest.

Tow-nettings from the Firth of Tay contained forty-five true marine plankton forms and a considerable number of bottom-living and littoral species. No rich seasonal development of neritic species was observed, and this may be attributed to the ebb and flow of the tide in the narrow estuary and to the large volumes of fresh water brought down by the Rivers Tay and Earn.

The fossil diatoms were obtained from the 25-ft. terrace (raised beach) exposed at various places between Dundee and Glencarse on the north bank of the Tay. The raised beach contains two well-marked layers of clay: the upper layer yellowish, sandy, and containing practically no diatoms; the lower layer of blue clay, and containing over forty brackish and marine forms. From the species found it is evident that when the blue clay was deposited the water was more brackish than it is in adjacent localities to-day. *Surirella pyriformis* Kitt., a common and characteristic diatom of the Tay to-day, was not found in the blue clay.

Only twenty species were found in the auxospore stage, and of these the majority occurred only once in that condition. A few diatoms, however, appear to produce auxospores fairly frequently, e. g. *Cymbella ventricosa* Kütz.

A new section of the genus *Navicula* is created for *Navicula gibbula* and allied forms.

Short descriptive notes are given on the localities and collections.

Professor F. E. FRITSCH emphasized the importance of the work on diatoms carried out by Dr. McCall. This group was either studied by microscopists without any considerable interest in the general aspects of botanical science or was dealt with by algologists, who had not the time or experience to treat them thoroughly. The speaker congratulated Dr. McCall on the thoroughness with which he had carried out his investigations, and commented on the large number of living species found in the Tay Estuary. It was striking that during such a systematic and prolonged investigation so few forms had been found with auxospores. He enquired

whether Dr. McCall had any views as to the possible means of survival of diatoms from one period of abundance to another.

Mr. J. RAMSBOTTOM congratulated the lecturer both on having had the courage to tackle a group of organisms which were unpopular and on the results he had obtained. He remarked upon the great economic importance of the systematic study of diatoms and the fact that large and valuable collections were awaiting expert examination.

Mr. D. J. SCOURFIELD asked if Dr. McCall had found the brackish-water diatom *Cylindrotheca* in the Tay district.

Dr. W. T. CALMAN associated himself with the remarks of the Botanical Secretary.

The AUTHOR replied to Mr. Scourfield that he had not found *Cylindrotheca* in the Tay district.

3 MARCH 1932

Professor F. E. WEISS, F.R.S., President,
in the Chair

The Proceedings of the General Meeting held on Thursday, 18 February 1932, having been circulated, were taken as read and confirmed.

The PRESIDENT referred to the loss the Society has sustained by the death of Dr. G. CLARIDGE DRUCE; those present rising in their places.

The PRESIDENT made an appeal to members to help him to raise a fund for the purchase of a portrait of Prof. JULIUS SACHS, one of the most distinguished of our former Foreign Members, the centenary of whose birth falls in the present year. The portrait has been painted by Prof. Sachs's daughter, a Munich artist, and it is hoped that it may be hung in the rooms of the Society.

A list of names of those who had made gifts to the Library since the previous meeting was read and laid on the table.

The following Fellow signed the Obligation in the Book of the Charter and Bye-Laws and was admitted:—Guy Coburn Robson.

Certificates of recommendation of the following candidates for Fellowship were read:—For the first time, in favour of Benjamin Peary Pal, David McCall, and Robert John Flintoff.

The following candidates, whose names were read for the third time, were balloted for and elected Fellows:—Idris Giles Lewis, Cecil Clement Dowding, Edward Thomas Brown, William Borlase, Alec William James Haggis, George Taylor, B.Sc., Robert Moyes Adam, Mary Ethelwyn Millner, M.Sc., Norman Woodhead, M.Sc., and Robert Wilfred Inder, B.A.

Lantern-slides illustrating *Oxalis natans* in South Africa.

By Sir Arthur W. Hill, K.C.M.G., F.R.S.

THE photographs were taken by Miss M. A. Pocock at Volvox Vlei, Cape Flats, near Capetown. The *Oxalis* is growing on the surface of the water of the Vlei, and the photographs were taken in September 1931. The *Oxalis* was shown in flower—the flowers being white—and the plant, which is tuberous, sends out long shoots which bear tufts of leaves which float like little boats on the surface of the water. In the summer time the vleis become quite dry and the shoots of the *Oxalis* die off, only the tubers remaining below the surface of the ground.

The PRESIDENT, after conveying the thanks of the meeting to Miss Pocock and Sir Arthur Hill, made some comments, and Mr. W. C. Worsdell also spoke.

Relative growth of mandibles in Stag-Beetles (Lucanidae).

By Professor Julian S. Huxley.

LINEAR measurements of length of mandibles and body (or elytron) made by Brindley, myself, and Dudich, respectively, in the males of three species of Lucanidae have been analysed. It is shown that the simple heterogony formula $y = bx^k$, where y = mandible-length, x = 'total' length (mandible-length + body-length), and b and k are constants, provides the basis for an expression of mandible-growth. The values of k are, for *L. cervus* about 2.3, for *L. lunifer* about 1.55, for *Cyclommatus tarandus* 1.97.

The approximation of actual to expected figures is close for the smaller individuals of each species. In all cases the curves bend over in the higher part of their range, the actual mandible-size falling progressively more and more below expectation. This, it is suggested, may be accounted for by the limited amount of food-material in the pupa being exhausted before very large mandibles can be formed.

In the holometabolous insects, such as the Lucanidae, it is assumed that the heterogonic relation between mandible and rest of body is produced in one of two ways—either by the formation of a substance responsible for heterogonic

growth of the mandible-rudiment, continuously throughout larval growth at a heterogonic rate ; or by the sudden appearance of heterogonic growth in the rudiments of the imaginal mandibles at a definite point in the pupal stage. Experiments on larval nutrition are needed to decide this point.

As a result of these facts it is concluded that the 'forms' of male Lucanids distinguished by coleopterists are purely growth-forms and have no systematic significance.

A tendency to multi-modality is evident in the frequency-curve for the mandibles of male *Cyclommatus tarandus* ; this appears to be correlated with the greater range of body-size in this species and consequent presumed greater variability of moult-number, as compared with the other Lucanids studied.

D'Arcy Thompson and Przibram have advanced a theory that the bimodality of heterogonic organs is due to a variation in moult number during larval life. This, however, as it stands, will not fit the facts, for it does not explain why the organ alone shows the bimodal curve while the rest of the body shows a unimodal one. If, however, it be supposed (1) that the processes influencing the rapid growth of a bimodal organ (e. g. the forceps of the male earwig) are always initiated at a fixed time after a moult, and that this moult is late in the animal's larval life ; (2) that the conversion into adult male-type forceps can only occur at the assumption of the imaginal state ; (3) that the assumption of the imaginal state can occur either at the next or the next-but-one moult after the growth-influencing processes have been initiated—then, if in some males there is one more moult than normal, such animals will show the 'high' type of forceps, while those with the smaller number of moults will show the 'low' type.

Lt.-Col. J. H. TULL WALSH having spoken, Mr. J. T. CUNNINGHAM asked if it was certain that the enlarged mandibles (in the male Stag-beetle) were not in some degree developed, either in substance or in form, before the beginning of the pupal stage, that is to say in the later larval stages, in the interior of the body, though not visible externally.

Dr. W. T. CALMAN expressed his appreciation of the work Professor Huxley and his pupils were doing in giving precise and numerical expression to phenomena of which systematists had hitherto been aware only in a very vague and general way. In particular he called attention to the importance of Professor Huxley's discovery that exaggerated growth in one member of a meristic series tended to spread to adjacent members, especially those lying posteriorly.

Dr. G. R. DE BEER supported Dr. Calman's remarks and said that he would like to go further, and to point out that, in addition to systematics, many other branches of biology were indebted to the novel view-point which had emerged from Professor Huxley's studies on heterogonic growth. Itself an important constituent of embryology, it derived additional significance and interest in connection with the demonstration of growth-gradients, and the possibility of comparing them with other gradient-effects, associated with the name of C. M. Child. Morphology itself could not afford to neglect heterogonic growth, since in those cases in which organisms possessed heterogonic organs and no fixed final adult size there was no fixed shape. With regard to palaeontology, heterogonic growth had contributed an acceptable interpretation of certain phenomena of so-called 'orthogenesis'. In conclusion, he asked Professor Huxley whether he had any notion of the physical basis of the constant differential growth ratios.

Prof. HUXLEY having replied, the thanks of the meeting were conveyed to him by the President.

Some new and rare British Crustacea.

By Mr. A. G. Lowndes.

BATHYNELLA CHAPPUISI (?) Delachaux. In June 1927 two specimens were obtained from the underground stone quarries at Corsham, Wilts, but they were not recognized as Syncarida at the time, and were placed on one side. They were recognized as Syncarida in October 1931, and Dr. Calman believes them to be *Bathynella chappuisi*, but they are not fully grown. So far I have failed to find any more specimens. No member of the Syncarida has so far been recorded from the British Isles.

Eurytemora thompsoni Willey. This Copepod was obtained from brackish-water pools at Lancing, Sussex, last June. Previously the only record was that of Prof. A. Willey, of McGill University, who found dead specimens in the gut of a fish caught in a weir at low water at Scotsman Bay, Nova Scotia. Dr. Smirnov, of Leningrad, has also obtained the species from the Sea of Okhotsk, but not recorded it.

Asellus cavaticus Schiodte. Several specimens, both male and female, were obtained during 1931 at Corsham when looking for *Bathynella*. The species is a blind Isopod which had only been recorded in the British Isles from wells at Ringwood, Hants, though the species is fairly common on the Continent.

Phyllognathopus viguieri Maupas. This is a small Harpacticoid which was first recorded in the British Isles by Mr. Scourfield, who obtained it from Bromeliaceous plants in Kew Gardens. It is to be obtained from similar situations in

almost any botanic gardens, and also occurred on one occasion in some experimental filters in the laboratories at Rothamsted. Lately I have obtained large numbers by soaking ordinary pineapple stems, with the leaves attached, in water. The species has never been found under really natural conditions in this country.

The PRESIDENT expressed the thanks of the meeting to the author, and stated that the matter was open for discussion.

Dr. W. T. CALMAN commented on the extreme interest of Mr. Lowndes's discovery of *Bathynella*, which had not hitherto been found nearer than Switzerland. It belongs to a very isolated order of Crustacea, the Syncarida, first discovered as fossils and later found to have living representatives in the Australian region and in the caves of central Europe. Several important contributions relating to the group have appeared in the publications of this Society since Mr. G. M. Thomson's description of *Anaspides* was published in the 'Transactions' in 1894.

Mr. D. J. SCOURFIELD said he had actually found *Phyllognathopus* several years before recording it in 1903. He would like to call attention to a very remarkable feature possessed by this form, namely, a pulsating or vibrating organ in the neighbourhood of the shell-gland. At first it was thought that this might be similar to the well-known vibratile organs in rotifers and many worm types, but it was shown later that the pulsation was really due to the rapid movement of a minute special muscle attached to a membrane forming the base of a small cavity.

PROFESSOR J. MCLEAN THOMPSON gave a summary of Dr. I. V. NEWMAN's paper 'Studies in the Australian Acacias.—I & II', which, after the thanks of the meeting had been given, was followed by a lecture by Professor J. MCLEAN THOMPSON entitled 'The theory of the Leguminous strobilus'. Professor R. R. Gates and the President having commented on the interest of the lecture, a vote of thanks to the lecturer concluded the meeting.

Studies in the Australian Acacias.—I. and II.

By Dr. I. V. Newman.

THE genus *Acacia* is one of the most remarkable genera of the Leguminosae, itself one of the most remarkable families of Flowering Plants. The series of Studies here introduced aims at a complete revision of the genus as found in Australia, where almost all known features occur, and will be centred round the phylogeny of the genus.

The systematic relations of the Leguminosae, Mimoseae, and *Acacia* as given by de Candolle, Engler and Prantl

(Taubert) and Bentham are reviewed. Bentham's division of the genus on foliage as the first principle of division, and the adoption thereof by authors of local floras is criticized as leading to too static a presentation. Distributed in all large land masses except Europe, the genus is particularly characteristic of Australia, where there are 500 species endemic out of a total of 700 species in the world. Only one Australian species occurs naturally on any other continent (*A. farnesiana*). The description of phyllodineous Acacias from the Tertiary of the Northern Hemisphere is regarded as erroneous on account of the scanty evidence and the fact (amongst others) that they do not occur naturally outside Australia at the present time. The habit, both vegetative and reproductive, is very diverse, as is the habitat of the genus. Except in connection with the anatomy and morphology of the foliage, very little is known about the internal construction and processes of the genus.

As relationships of organs rather than forms of organs are features susceptible of more prolonged or of repeating changes, they are considered as more suitable for the major divisions of a phylogenetic classification. Such relationships find expression in the forms of inflorescence and flower-groups, which are therefore taken as the first two principles of division. The changes are between the flower-groups in the inflorescence, and between the flowers in the flower-groups. Because, whatever be the form of the flower-groups, they are the parts of the inflorescence, the form of the latter is taken as the primary principle of division. The leaf-form is the third principle. This proposed phylogenetic classification starts, therefore, from a primitive form having racemose inflorescences of spikes of flowers and with true leaves (*Racemoseae-spicateae-phyllae*). Modification of the inflorescence can proceed by condensation through a condition with clustered flower-groups (*Constateae*) to one with solitary flower-groups (*Singulares*). By diminution of the vegetative axis and foliage, this condition could proceed to a simulation of the *Racemoseae*, and the line of transition be carried out again. At any stage in the transition the flower-groups could change from long spikes by condensation through dense, oblong spikes (*Oblongae*) to globular heads (*Globulae*). By reduction of the heads to single flowers with diminution of the inflorescence axis, a condition simulating solitary spikes (*Singulares-Spicateae*) could be obtained, and the line of transition in the flower-group be able to be repeated. At any stage in these lines of transition a third could take place in the foliage, proceeding through loss of lamina (*Phyllodineae*) to loss of the entire leaf, with functioning of small branches (*Phyllocladineae*). This line cannot repeat itself. A little thought shows the scheme to

bristle with cross-lines of transition in great complexity. This complexity explains some of the difficulty in classifying some species of *Acacia*, and provides a possible cause of certain genetical anomalies, e.g. inter-sterility of two apparently closely related species of *Crepis* while they are both inter-fertile with an apparently more distant species. The third would lie near the join of the lines of transition of the other two. In the distribution of the genus, the recapitulatory evidence from the seedling leaves, the anatomy of the foliage, and the arrangement of the flowers in the flower-head there is some support for the suggested scheme of classification.

In Study II the ecology, habit, floral structure, and the reproductive processes up to the formation of the spores of *Acacia Baileyana* are considered. The species is closely related to *A. polybotrya* and *A. pruinosa*, and in cultivation is suspected of taking part in hybridization.

The species occurs in a restricted area near Cootamundra and Wagga Wagga in the south-east of New South Wales, Australia, and appears to be associated with the conjunction of three conditions of environment—Silurian rocks, 18"–23" rain/ann., 500–1,500 ft. altitude.

The foliage is very glaucous, the height of the tree is between 5–8 metres, and there are pubescent and glabrous types. There are variations in the number of pinnae, the direction of rotation of the $2/5$ phyllotaxy, the number of flowers in a head, and (slightly) in the number of floral members (except the gynoeceum). The incidence and mode of sterility is very variable. By means of a model, measurements on serial longitudinal sections and serial transverse sections it is concluded that the flower-head is a condensed spike, the spiral of phyllotaxy having been made discontinuous in the process of condensation, so that the flowers appear in horizontal groups of five. A theoretical explanation of this is given. The method of termination of the axis of the flower-group is indefinite. The species appears to be in a labile condition.

The members of the floral whorls are described as arising in a spiral manner. Striking differences produced by the same stain on material killed in different fluids are made very clear by the presence of a mucilaginous substance in the sepals and legume. The minute anther with its eight microsporangia, each producing one 16-grained pollinium, is borne introrsely on a long thin filament. The superior gynoeceum is in the form of an infolded leaf, the epidermes of whose appressed margins can be clearly seen in thin sections. The midrib proceeds into the style; but not the marginal bundles. The ten or twelve ovules are borne equally along the margins of the legume, and are from semi- to fully anatropous. There

is a case of a small flower growing as a continuation of the axis of an older flower, suggesting that the legume is a lateral structure to a suppressed apex. The unitary nature of the legume is considered established, as against the binary nature postulated under the theory of Carpel Polymorphism, and its foliar nature is supported as against the Phylloclade Theory.

The occurrence of sterility in its various modes is discussed. It is possible that a few pollen-grains might be formed with aberrant chromosome conditions. A connection is demonstrated between the absence of a mucilaginous material in the young legume and the presence of sterility. The sterility in *Acacia Baileyana* shows no trend towards the substitution, or entire elimination, of reproductive parts.

The very early stages of the microsporangia and of the ovules were not seen clearly. The anther is regarded as having eight separate archesporia, each of which produces a plate of four mother cells. The tissues of the anther are very reduced. The endothecium is one layer only. There is a characteristic single-layered inner tapetum with 'exine' facing the spores. The megaspore mother cell develops as usual from a single hypodermal archesporium, and gives rise to three or four megaspores in an axial row. Of these, either the chalazal or, more frequently, the distal one functions. There is a definite parietal tissue capping the mother cell or megaspores, but no definite tapetum. The ovule is naked, the integuments being only just discernible near the bend of the funiculus, and arising late.

The formation of the spores from the mother cells is followed in some detail, particularly for the microspores. The mother cell nucleoli have different appearances with different classes of fixative. At diakinesis there is a strong suggestion of the presence of types of chromosome, both in length and configuration—three or four small and ten or nine long. Trabants are also suggested at this and some later stages. Otherwise the process of meiosis appears to be as usually described. Discussion is given of the implications of the Chiasmatype theory of meiosis where a heterotypic daughter cell fails to divide but functions as a megaspore. The germination of such a 'spore' should always manifest cytological phenomena, and sometimes produce genetical results different from those in the case of a normal spore.

The chromosome number of thirteen is unusual among the Leguminosae, and suggests a tetraploidy based on the commoner numbers, six and seven.

Professor GATES remarked that Dr. Newman had spent two years in his laboratory investigating an immense amount of material of the genus *Acacia* which he had brought with

him from Australia, and this paper represented a portion of the results. Dr. Newman had done an extremely good piece of work. He had shown great care and attention to detail in the development of methods of morphological and cytological investigation in the genus, and it was very important that Dr. Newman should have the opportunity of continuing in Australia his comparative studies of the genus which he had begun so well. It was a curious fact that since the papers of Engler and Guignard, over fifty years ago, the floral structure of the genus, with its curious pollinia and rudimentary integuments, had been practically untouched. Dr. Newman had outlined a new classification of the genus, the details of which were to be filled in and tested later. His scheme breaks up the Phyllodineae, and indicates that there has been a large amount of parallel evolution in the genus, not only in the development of phylloclades, but also in the reduction and condensation of the inflorescences.

The PRESIDENT remarked on the obvious care with which these studies were being carried out, and wished Dr. Newman success in the scheme of investigations which he had mapped out. He thanked Professor McLean Thompson for so kindly coming from Liverpool to give a summary of Dr. Newman's studies.

**The theory of the Leguminous strobilus. By Professor
John McLean Thompson.**

ACCORDING to this theory, at some early stage in descent a Leguminous flower was strobiloid. Its organs were displayed in spiral succession, and were more numerous and more widely spaced than in any of the modern species. The basal organs were leaf-like and comparatively numerous. For the greater part they were sterile, though grading upwards into microsporophylls. Whatever were the forms of the latter, their modern equivalents are stamens. The flower was apetalous in the sense accepted for modern species. The microsporophylls and megasporophylls were leisurely produced; the latter were terminal, and the transition from vegetative to reproductive organs was gradual. In time the strobilus was shortened and the floral part-number was restrained. The transition from vegetative to reproductive organs was accordingly more clearly defined and localized as the influences directing the nature of the floral organs were expressed in more limited zones of the condensed receptacle. The equivalent of the modern corolla gradually arose in many species from such primordia in the zone of transition as were not fully committed to the vegetative group, and were affected in part by reproductive influences. Their early ontogenetic bias was towards vegetative development: their later developmental

history was controlled by closely contending vegetative and reproductive forces. The number and nature of the petals thus produced were at first varied. When the limits of vegetative and reproductive control in the receptacle had become more clearly prescribed, the number and nature of the petals were more strictly determined. Meristic variation, though of narrowed limits, persisted. As in some modern species, petals need not have arisen when the limits of vegetative and reproductive control were more clearly marked. Throughout, the part number of the lower vegetative organs was reduced by both inhibition of their primordia and limitation of the zones of the receptacle in which vegetative and reproductive influences respectively predominated. The modern bract, bracteoles, and calyx gradually emerged as residual organs of the vegetative group. The production of microsporophylls was now greatly reduced; the forms of the microsporophylls were in time more or less stereotyped, and their stamen nature was fixed upon them. The spiral succession on an elongated receptacle was early of variable order of divergence, but as the spiral succession was condensed the $2/5$ succession tended to prevail as in modern species. Local crowding of floral organs was inevitable, and local suppression or displacement became general expressions of the crowded succession. The original gynoeceium was terminal, its axis was receptacular and elongated as a stalk or gynophore, and it showed branching. It shared with the receptacle as a whole the power of secondary growth, as in many modern species. Its branches were produced in spiral succession and bore naked ovules. As curtailment of the floral receptacle advanced the ontogenetic inception of the gynoeceium was hastened, its branch primordia became limited in number, the gynophore was generally shortened, and arrest or suppression of certain of the crowded gynoeceial branches was inevitable. Whatever had been the determining factors in reduction of the strobilus as a whole, the surviving gynoeceial branches had become organs of limited growth. The stigmatic surface arose as growth of the gynoeceial branches was restrained. The surviving gynoeceial branches gradually assumed their modern form of ovuliferous phylloclades of essentially uniform type, with secondary growth maintained as in many modern species. As their infolding, by inequality of growth rate, was accomplished, the modern ovary and placentae were more strictly defined. The legume character was completely expressed as the more apical portions of these megasporophylls were sterilized and the styles were provided.

In the vast majority of species the gynoeceium was gradually reduced to a single legume, still stalked or now sessile. The gynoeceium was now produced in close relationship of both

time and space with the restricted androecium, and stricter control of floral part-numbers of every category was displayed. Such control is manifest in modern species which show widespread suppression and omission of floral parts arranged in $2/5$ spiral succession. As the modern species arose, arrest, partial or complete, of either the gynoecium or the androecium was ever imminent, and separation of the sexes occurred. Perigyny is a modern development of the reduced strobilus, its incidence is virtually limited to species with low floral part-number, and its dominance and effects are best shown in the modern *Bauhinieae* and *Papilionaceae*.

On this theory the flowering of the *Leguminosae* is brought into line with older views on the *Ranales*. It is based on ontogenetic evidence from a comprehensive series of modern species in which arrest or suppression of floral parts, displayed in spiral succession, has been demonstrated, with change of interval between successive floral organs at whatever point in ontogeny a biological advantage may be assured by displacement of a primordium. It is shown that when, as in the *Acacias*, the floral part-number is high, the successive changes of interval are small, and are the minimal changes offering liberty to the floral organs already formed and in process of formation; when the floral part-number is low, the marked changes of interval entailed are likewise minimal, offering full liberty for the floral organs as a whole. Herein are two views of the Leguminous flower which are not mutually exclusive. On the first, the number of floral organs is inherent in the young receptacle before primordia have been defined. The positions on a spiral course at which the development of the potential number of primordia may occur is already defined for any one species, and withdrawal or advancement of primordia at a definable number of points is early determined. On the second view, change of interval between succeeding floral organs did not occur in the extended receptacle of the ancestral strobiloid flowers. As the strobilus was reduced, the phyletic spiral succession was, in general, maintained, but with withdrawal or advancement of primordia which would lie in too close radial association with established floral organs. To the inherent or phyletic tendency of ontogeny increasing nutritive or spacial difficulty had been opposed, and as the potential floral part-number fell, the latitude of primordial displacement increased, until, on a $2/5$ spiral succession, the maximum advancement or withdrawal of primordia involved a change of angle of 36° . The choice between advancement and withdrawal lay in the relative ease with which nutrition could be maintained in new alternative positions.

On the theory as a whole some aspects of meristic variation may be readily understood. Thus the passage from hexamery,

through pentamery and tetramery to trimery, would depend rather on the dominance of influences, vegetative and reproductive, on the spirally ascending primordia in Leguminous flowers than on any obligate production of floral parts of varied category in uniform number. Thus in the ancestral forms the transition from vegetative to reproductive floral organs was gradual, and the number of floral parts now classed as bracts, bracteoles, and sepals was relatively high. As the strobilus was curtailed, and the categories of floral parts were more clearly defined, meristic variation became more clearly evident. As the reduction of floral part-numbers progressed, the transition from vegetative to reproductive influence tended to be abrupt. The meristic variation of the basal vegetative organs of the flower was reduced to narrow limits, and is now so restrained as to merit recognition as exceptional rather than as the rule. On this view the petal is no longer an organ *sui generis*, or a transformed or degraded stamen or promoted sepal, but rather an organ of transition from calyx to androecium, liable to replacement during the ontogeny of the flower by either a sepal or a stamen, according to its position on the spiral course. The condition postulated is fulfilled in the Leguminosae, and apetalous species such as *Saraca indica* and *Dialium guianense* may be taken in point of reference. Both tetramery and trimery in the Leguminosae need no longer be expressed as resultants of immediately succeeding sectorial growth units, so arranged on the floral receptacle as to share, to the exclusion of other primordia, the available receptacular surface. Thus the generalization of Hofmeister, recently revived by Priestley, becomes unnecessary and, indeed, inapplicable. For both tetramery and trimery in the Leguminosae result from both fusion and arrest of floral part primordia arranged in 2/5 spiral succession, and from meristic variation as above considered, by which pentamery also may be, and is, provided. It is not necessarily imagined on the theory that the now dominant 2/5 succession in floral-part initiation has always been provided in the Leguminosae, but rather that from more complex and variable arrangements the spacial relationships of such a succession are now dominantly determined.

In the absence of numerous close gradations from the supposed elongated strobiloid Leguminous flower to such types as now show marked perigyny, it is suggested that curtailment of the strobilus has for long been pursued, is shown in its minimal condition by the Acacias and in its most extreme forms with perigyny in the modern Piptadenias.

The PRESIDENT thanked the lecturer for the clear exposition of his interesting views on the origin of the Leguminous flower.

17 MARCH 1932

Professor F. E. WEISS, F.R.S., President,
in the Chair

The Proceedings of the General Meeting held on Thursday, 3 March 1932, having been circulated, were taken as read and confirmed.

The PRESIDENT announced that the Council had awarded to Professor EDWIN STEPHEN GOODRICH, F.R.S., the Linnean Gold Medal, to be presented at the Anniversary Meeting on the 24th May next.

A list of names of those who had made gifts to the Library since the previous meeting was read and laid on the table.

The following Fellows signed the Obligation in the Book of the Charter and Bye-Laws and were admitted:—Robert Benson Ewbank, C.I.E., Mary Ethelwyn Millner, John Noel Milsum, and George Taylor.

Certificates of recommendation of the following candidates for Fellowship were read:—For the second time, in favour of Benjamin Peary Pal, David McCall, and Robert John Flintoff: for the first time, in favour of the Right Hon. The Earl of Cranbrook.

Certificates of recommendation of the following candidates for Foreign Membership were read for the first time:—Professor Klas Robert Elias Fries, Professor Eduard Fischer, Professor Ludwig Jost, and Professor Emile Topsent.

Exhibit of a remarkable larval Cephalopod. .
By Mr. G. C. Robson.

MR. G. C. ROBSON exhibited lantern-slides illustrating the 'Rhynchoteuthion' stage in the development of the Ommastrephidae (Decapod Cephalopoda). At this stage the young squid has the tentacles fused together to form a tubular structure (*Rüssel* of German authors), in which condition they continue until the squid is 8–10 mm. in length. The tentacles then come apart and assume the normal form and position. Mr. Robson's observations were based on an extensive series of specimens obtained by Dr. W. Beebe in the E. Pacific.

The PRESIDENT inquired if anything was known as to the food of these juvenile forms, as the tubular structure might be possibly an adaptation to some special mode of feeding.

Mr. J. T. CUNNINGHAM asked whether the tube described by Mr. Robson was ciliated internally.

Sir SIDNEY HARMER asked Mr. Robson to explain in greater detail the relations of the tentacles to other parts, and to give further information with regard to their tubular character when united.

Mr. R. H. BURNE asked whether the fusion between the tentacles was confined to the epithelium, and drew attention, if such were the case, to the parallel presented by the temporary epithelial fusions that occur in mammalian embryos, in particular the fusion of the lips in young marsupials.

Dr. W. T. CALMAN remarked that on the analogy of similar cases among Crustacea he would have been inclined to suspect that two or more species had been wrongly combined in one developmental series. As he was assured, however, by Mr. Robson that there was no possibility of this, the very remarkable course of development that had been described must be accepted as proved. As far as he was aware it had no close parallel elsewhere in the animal kingdom.

Mr. ROBSON replied.

Mr. J. T. CUNNINGHAM gave his account of a paper entitled 'The dehiscence of the sporocarp and germination of the spores in *Marsilia polycarpa* Hook. & Grev.', by himself and Mr. D. M. REID. After comments by the President (who conveyed the thanks of the meeting) and Dr. D. H. Scott, Mr. Cunningham replied.

Some Dune-slack Liverworts, including fertile specimens of *Petalophyllum Ralfsii* Gottsche. By Professor E. J. Salisbury.

PROFESSOR SALISBURY exhibited living fertile specimens of three characteristic liverworts of 'dune-slacks' growing together, viz. *Petalophyllum Ralfsii*, *Moerckia Flotowiana*, and *Aneura pinquis* v. *crassa*. He described how the two former persisted during the summer, partly through being covered with blown sand, but mainly by means of the thickened midribs. In *P. Ralfsii* the midrib developed terminally into a tuber containing fungal hyphae, and the lamina was renewed when conditions again became moist.

After the thanks of the meeting had been conveyed to Professor Salisbury, the PRESIDENT also showed specimens from Cumberland and Mr. J. RAMSBOTTOM spoke.

Problems of desert vegetation.

By Mr. Eric Ashby.

THE problem which faces all life in the desert, whether of man or animals or plants, is the problem of water economy. Yet it is significant that there are very few areas on the earth from which life is excluded through lack of water. The barrenness of parts of the Sahara is due to the shifting nature of the sand; that of the desert of Utah is due to the high concentration of salts; and the barrenness of the mountain tops is due to cold.

The following account embodies sundry observations upon the environment and vegetation of the Sonoran Desert. This desert is bordered on the north by the Colorado Plateau, and in the south it merges into the thorn forests of Mexico. The region offers a great deal of interest to the ecologist, for the problem of water economy has been overcome in a variety of ways, and the desert is peculiarly rich in vegetation, on account of the biennial seasons of rainfall.

The temperature of the desert ranges from freezing-point and lower, during the winter nights, to 110° and higher, in the shade in the summer; but a frost never lasts more than twelve hours, and on an average two hundred and forty days in the year are free from frost.

The greatest annual rainfall ranges around ten inches, though it has been as low as five inches. It falls into two well-defined seasons—Summer (July–September) and Winter (December–February). Most of the rain falls in July, in storms of tropical intensity. Indeed, on one occasion five inches fell in one day, and it is not infrequent for half the annual rainfall to come within two weeks.

A corollary of these bursts of rainfall is the occurrence of long periods of drought, and it is only those plants which can endure such periods which remain the regular denizens of the desert.

Plants in the Sonoran Desert tide over these periods of drought in one of three ways. Very many of them die as the water shortage becomes acute, and are perpetuated by means of seeds. Such plants are somewhat misleadingly called ‘annuals’. During the dry periods they remain in the soil as seeds. A few days after the first appreciable rain the ground becomes carpeted with seedlings, and the colour of the desert turns suddenly from brown to green. During the rainy period these plants grow with surprising rapidity. In a few weeks they are in flower and fruit; and by the time the dry season begins again the seeds are dispersed and the short-lived population has withered away.

There are two such crops of ‘annuals’ in the year, corresponding to the summer and winter periods of rainfall.

A comparison of these species at these two periods reveals one very striking fact: that the summer 'annuals' are a completely different flora from the winter 'annuals', *not one species being common to the two periods.*

It is believed that this complete contrast between the summer and winter floras is due to the selective action of temperature upon germination. Temperatures during the summer rainy period are consistently high; during the winter rainy period the night temperatures are sometimes below freezing-point. If this is indeed the explanation—and there is experimental evidence to support it—it is a most striking instance of the importance of temperature for the germination of species.

The most characteristic plants in the Sonoran Desert are the succulents, and these tide over the dry period in a totally different way. In fact, it may be said that *internally* they never suffer shortage of water. Their root system is shallow, and drains a relatively large area of the surrounding soil. After a rain it is easy to measure the increase in girth of the fleshy stems. In the ensuing dry period the water loss from the succulents is reduced to a minimum. During the hotter days the stomata are closed, so that the water supply is preserved in what is virtually a waterproof bag. It is estimated that a giant cactus such as *Pachycereus* may store as much as eight tons of water.

The third group of desert plants do not store water against the dry season, nor do they die and leave only seeds behind them. They are deciduous; immediately the soil becomes dry they lose their leaves, and the bare branches which remain are able to endure wilting for long periods without harm. These plants are among the most successful desert plants, and they present the deepest problem to the ecologist, for they transpire water very rapidly (relatively more so than mesophytes*), and they have no *apparent* method of surviving the dry season. Their adaptation undoubtedly lies in the property of the protoplasm to withstand desiccation, and it is to the interpretation of this type of physiological adaptation that the ecologist will have to turn for a solution of the problems of desert vegetation.

The thanks of the meeting having been expressed by the PRESIDENT, the following added comments, and the lecturer replied,—Professor E. J. Salisbury, Mr. R. Paulson, Professor J. R. Matthews, Mr. A. D. Cotton, Dr. T. A. Sprague, and Mr. J. Ramsbottom.

* I have given some data upon the transpiration of these desert plants in 'Ecology', xiii, 1932, pp. 182-8.

14 APRIL 1932

Professor F. E. WEISS, F.R.S., President,
in the Chair

The Proceedings of the General Meeting held on Thursday, 17 March 1932, having been circulated, were taken as read and confirmed.

A list of names of those who had made gifts to the Library since the previous meeting was read and laid on the table.

The following Fellow signed the Obligation in the Book of the Charter and Bye-Laws and was admitted :— Clifford Gerald Hansford.

The PRESIDENT announced that the following notice had been received from the Secretary of the Sixth International Botanical Congress :—

‘ According to a decision by the Fifth International Botanical Congress at Cambridge in 1930, the Sixth Congress will be held in Holland in 1935. An Executive Committee has been formed, the President of which is Professor Dr. F. A. F. C. Went (Utrecht), while Professor Dr. J. C. Schoute (Groningen) will act as Vice-President, Dr. W. C. de Leeuw (Bilthoven) as Treasurer, and Dr. M. J. Sirks (Wageningen) as Secretary. The Committee has decided that the Sixth Congress will meet at Amsterdam, 9–14 September 1935. Scientific societies are kindly requested to reckon with these dates in planning their own meetings.’

In accordance with Chap. X, Sect. VII of the Bye-Laws, the following Fellows were elected, by show of hands, as Auditors of the Treasurer’s Accounts for 1931–32 :—

Representing the Council : Mr. I. H. Burkill.
Dr. Philippa C. Esdaile.
Representing the Fellows : Mr. R. H. Burne.
Mr. H. W. Pugsley.

Certificates of recommendation of the following candidates for Fellowship were read :—For the second time, in favour of The Right Hon. The Earl of Cranbrook ; for the first time, in favour of George Francis Scott Elliot and Martin Audley Foquett Sutton.

Certificates of recommendation of the following candidates for Foreign Membership were read for the second time :— Professor Klas Robert Elias Fries, Professor Eduard Fischer, Professor Ludwig Jost, and Professor Emile Topsent.

**Some unusual female catkins of *Corylus*. By Professor
F. E. Weiss, F.R.S., Pres.L.S.**

As is well known, the female catkins of *Corylus* arise as lateral structures in the axils of foliage leaves. In the autumn they are indistinguishable from vegetative buds, and it is only in spring, when the red stigmatic filaments project, that they can be recognized as reproductive organs. They are evidently much reduced inflorescences producing only six to eight pairs of ovaries, each surrounded by a small involucre formed by the fusion of a bracteole and two secondary bracteoles. Each pair of ovaries is subtended by a small oval bract.

TEXT-FIG. 1.



Young vigorous shoot of *Corylus* bearing male catkins in the axil of the lowermost of the three leaves and a female catkin in terminal position at the end of the shoot.

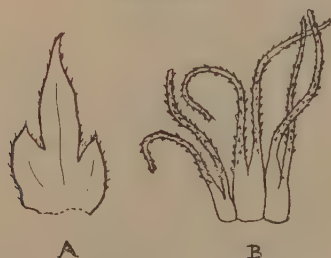
When hazel bushes have been cut back in hedging they produce numerous vigorous unbranched shoots which, after bearing a number of foliage leaves, taper off into tips clothed with small bracts. In the lanes of Westmorland and Cumberland I have sometimes found that these sappy shoots end in the autumn in the production of female catkins which occupy a terminal position. Such catkins are easily recognizable, consisting as they do of twenty to thirty bracts, between which the stigmatic filaments project (see text-fig. 1). These

filaments are not red as in the normal inflorescences, but are green, and have obviously no chance of being pollinated, as the normal male catkins are still immature.

On dissecting these autumnal female catkins it will be seen that their ovaries are borne in groups of three (see text-fig. 2, B) so that the median flower which is present in *Betula* is developed in these abnormal female catkins, while it is absent from the normal inflorescences of *Corylus* and also from those of *Carpinus*, which is closely related to *Corylus*. Occasionally this median flower may be found in normal female catkins of the hazel.

Another character which these catkins of *Corylus* share with those of *Betula* is the fact that the bract subtending each group of three flowers is tripartite, consisting, apparently, of a bract and two bracteoles fused together (see text-fig. 2, A),

TEXT-FIG. 2.



Dissection of abnormal female catkin of *Corylus*.

- A. Subtending bract to which the two bracteoles are fused.
B. The three female flowers, one median and two lateral, found in the axil of A.

while in the normal catkin of *Corylus* the subtending bracts are simple and oval, the bracteoles taking part in the formation of the involucre together with the secondary bracteoles. Of these latter there was no trace in the abnormal autumnal catkins.

These unusual catkins are of interest, as they probably represent an ancestral condition of the female inflorescence before it had become reduced to the bud-like structure which at present represents the female catkins of *Corylus*. In the more primitive condition the terminal catkins consist of a larger number of flowers in groups of three, subtended by a bract to which two bracteoles are fused. In all these particulars they resemble very closely the female catkins of *Betula*, and emphasize the relationship of *Corylus* and *Betula* already expressed by systematists in placing *Corylus* in a subfamily of the Betulaceae.

Mr. I. H. BURKILL commented upon the peculiarly interesting association of two abnormalities following upon the pruning, the first the outgrowing of the terminal bud, normally arrested in nature, and the second the development of the median florets in its catkin.

Dr. T. A. SPRAGUE considered that the mutilation (cutting-back) of the hazel bushes concerned supplied the stimulus occasioning the reversionary phenomena described by the President. Where reduction had occurred in the course of evolution, cutting-back frequently caused reversion, owing to the increased amount of sap available for the reduced number of growing points. Thus, mutilation in the common Ash, *Fraxinus excelsior*, frequently resulted in the production of shoots bearing leaves in whorls of three each, a condition regarded by Dr. Sprague as primitive for the Oleaceae; and he had observed in the Murree Hills, Punjab Himalaya, shoots of a coppiced *Pyrus Pashia* bearing *pinnatifid* leaves in the place of the usually *undivided* ones.

The PRESIDENT having replied, the Vice-President in the Chair (Mr. FRANCIS DRUCE) conveyed to him the thanks of the meeting.

Exhibit of specimens of mosses acting as 'Tumble-weeds'.

By Mr. H. N. DIXON.

FRAGMENTS of moss detached from the soil having become lodged in hollows from which they could not escape, while subject to slight movement by the wind, had continued producing branches in all directions, according to the temporary position of the tuft, until all differentiation of basal and terminal end had disappeared, and the plant sometimes had taken on a perfect spherical form, in others a subspherical, lenticular or bun-shaped form. In these conditions they were easily driven for considerable distances by the wind, thus aiding in the spread of the species. Only four kinds of moss have at present been known to act thus, three being British and one in New Zealand.

Mr. H. N. RIDLEY pointed out that in the Scotch mountains, where the fierce gusts of wind tore up the peat and transported bits to a considerable distance, moss-plants would undoubtedly be carried with them, and referred to the fact that the widely dispersed lichen *Usnea barbata*, known to Malays as the 'excreta of the wind', owed its distribution all over the world to the action of wind transporting whole plants, and many mosses at high elevations might be similarly borne.

The PRESIDENT expressed the thanks of the meeting to Mr. Dixon.

The Tree Senecios of the high African Mountains.

By Mr. A. D. Cotton.

The tree Senecios, which in growth-form belong to the branched 'rosette tree' type as defined by Warming, are confined to the six high mountain masses of East Tropical Africa mentioned below, all of which lie within 4° of the Equator. They possess a stout woody trunk, rosettes of large leaves, and very large terminal panicles of flowers. The branching is (usually) dichasial, two lateral buds developing after flowering and continuing the axis, so that the stem architecture is cymose. A characteristic feature is the mass of marcescent foliage, especially in the forms inhabiting the highest altitudes. All species are peculiar to the mountain mass on which they occur.

The species occur in zones, and their bulky and often grotesque forms are a most striking feature of the sub-alpine and alpine regions of the mountains. Their distribution is as follows, the species being given in order of decreasing altitude:—

RUWENZORI.

S. Friesiorum Mildbr.
S. adnivalis Stapf
S., sp. n.
S. longiligulatus de Wild.

VIRUNGA RANGE.

S. alticola (Mildbr.) Th. Fries
S. Erics-Rosenii R. E. & Th. Fries

MT. ELGON.

S., sp. n.
S. elgonensis Th. Fries
S., sp. n.

KILIMANJARO.

S. Cottonii Hutch. & Taylor
S. kilimanjari Mildbr.
S. Johnstonii Oliver

MT. KENYA.

S. keniodendron R. E. & Th. Fries
S. Battiscombei R. E. & Th. Fries
S. Brassica R. E. & Th. Fries

ABERDARE RANGE.

S. aberdaricus R. E. & Th. Fries
S. brassiciformis R. E. & Th. Fries

Those species occurring in the sub-alpine zone (9,000–11,500 ft.) have large heavy leaves, which are glabrous or protected by a moderate tomentum. The species of the alpine zone (11,500–14,000 ft.) ascend almost to the limit of vegetation where extreme contrasts in weather conditions obtain, rainy periods alternating with periods of drying winds, and hot sun by day alternating with severe night frosts. The leaves of these species, which, in spite of the conditions, are often exceedingly large, contain numerous mucilage (or oil) ducts, and are protected on the under-side by a very dense tomentum which may be short or shaggy.

The origin of the giant Senecios has been sought in one or more common ancestors formerly widely distributed, which, with the advent of warmer conditions, ascended higher up the mountains, and have since become specialized into distinct species. The discovery of some new species at the

junction of the forest-belt and the sub-alpine region which are intermediate in form between the typical 'giant' *Senecios* and the forest species, indicates that the upper forest-belt of the respective mountains cannot be ignored as a possible source of the alpine tree-forms.

Reference was made to the ecological features of the mountains and to the comparable growth-form exhibited by the genus *Espeletia* in similar latitudes on the Andes of Colombia.

The PRESIDENT expressed his thanks to Mr. Cotton for the very clear way in which he had given his account of the interesting series of *Senecios*. The distinct species existing on the separate mountains reminded him of endemic species characteristic of insular floras. He would like to ask whether the alpine forms were likely to have been derived from the less modified forms found in the forest region by adaptation to more rigorous conditions.

Dr. O. STAPF asked if any differences in floral structure could be detected between the flowers of the typical species of *Senecio* and those of the 'giant' species, and whether annual rings were present in the wood.

Mr. COTTON replied that no traces of annual rings were present in the species he had examined. The floral structure appears to be normal.

Biological principles in the control of destructive animals.

By Martin A. C. Hinton.

THE destructive mammal problem has forced itself upon human attention since the very earliest times. Its cruder or simpler forms, as presented to us, for instance, by the larger and fiercer *Carnivora* when they seek to devour our domestic animals or ourselves, or by certain ungulates when they enter our fields and gardens in order to steal or destroy our crops, have quickly found solutions in all parts of the world. Man learned everywhere to protect himself and his belongings behind barriers of all kinds, supplemented, when necessary, by the use of fire. The earliest textbook on the subject (which I have not seen) probably said:—'If you cannot cage your wild beasts, then encage yourselves.' That was the first step—or rather the second; for a long series of experiments, sometimes repeated even in our own day, had already conclusively demonstrated that flight was always tiring and often ineffectual. Then came the invention of weapons. This, too, had simple beginnings, for weapons of defence may be said to have been invented by the first woman who protected her babe from a wolf with a brand snatched from the fire, or by the first man who threw a stick, or a stone, or even the

baby, at that wolf to protect his dinner. Similarly, the first stout-hearted fellow who sharpened a stick or a stone and went out to slay the wolf may be hailed as the first and true inventor of weapons of attack. From such humble beginnings, by means of a long chain of weapons in wood, stone, copper, bronze, iron, and steel, we have arrived at the modern rifle and machine-gun. And from the corrosive sublimate and phosphorus of the Middle Ages we have got to poison gas and strychnine. By these many inventions man has completely turned the tables on his ancient foes, and from being the attacked he has become not only the attacker, but the exterminator. Species after species, in all lands and in all seas, have succumbed before the attacks made upon them by men seeking safety, riches, or sport, until at length the poor zoologist has to confess that the white man is, perhaps, the most dangerous mammalian pest in the world. But, thanks largely to the advancement of science, men seem about to realize at last that every species is worth keeping for itself, provided that we can control its numbers, distribution, and activities. Of course, every so-called noxious species will cost something to preserve; but whether we have to pay much or little for it depends entirely upon ourselves. That the price is worth paying cannot be doubted when we reflect that each species is really a page in the great book of evolution, with its own history and its own special message for the man who can read it. With its aid we may read other pages; but, without, many may become meaningless.

One of the most important characters of mammals, a character which they share with birds, and possibly with some few lower animals, is their educability. Lankester is usually cited as the first to draw such a distinction between the mammals and birds on the one hand and the lower animals on the other. But a knowledge of the fact that mammals are educable is a very ancient possession: and I am sure that Dr. Calman could furnish me with half a dozen quotations from Solomon or some other writer of respectable antiquity to prove that point. Because they are educable, wild mammals and birds learn to avoid man, and especially the man with a gun. They can also be taught to shun cultivated places if all that enter there are frightened, hurt, or even killed. Thus the scarecrow gains its efficiency in our fields, and thus the Game Warden in Uganda protects the shambas from elephants. It is along such lines rather than by methods of extermination that we should proceed against the larger destructive mammals.

Let us look at the case of the African Elephant a little closely. Even in Africa space is strictly limited, and the area suitable as dwelling places and feeding grounds for

elephants is steadily dwindling before the advance of civilization. Probably three or four young elephants can get a living on the food and space that would suffice for one old bull alone. So that old bulls form one of the great checks upon the undue increase in the numbers of elephants. But for many years ivory hunters have systematically and relentlessly pursued the great tuskers, i.e., the fully mature and old bulls; and in recent years the law in most parts of Africa has protected the calves—not that there was any commercial inducement to shoot them. We have thus destroyed an essential part of the natural mechanism by which the numbers of elephants are controlled. As a result complaints come from Uganda that the number of elephants has increased alarmingly, and that in many districts repressive steps have had to be taken against them. Were I a dictator, I should now order, both in the interests of the elephant and of the colony, a drastic thinning out of the calves and adolescent elephants and strict protection of all the sizable individuals. Every calf that entered a shamba would be killed, but every sizable animal would be scared away if possible. Naturally I should watch the progress of the experiment and its effects with the utmost attention, ready to denounce and stop it if an unforeseen disaster threatened. In all such matters one must be prepared for the unexpected; and that which will work in one part of a continent may fail in another.

It is not merely for aesthetic reasons that I would urge the preservation of such formidable animals as the larger cats and dogs. Although, perhaps, not to be tolerated in close proximity to human settlements, they should be given sanctuary in all those reservations for wild life which have been established in various parts of the world. This does not mean that they should be allowed to breed entirely without control in such places: but the numbers of the larger Carnivora are chiefly dependent, in natural conditions, on the numbers of the ungulates. They have to run for their dinners, and the value of the dinner depends upon the distance to be run. In these two facts lies the secret of the natural control of the carnivorous population.

In North America they have made great efforts in recent years to control or, rather, eliminate many of the larger predatory mammals. One of the species brought to the verge of extinction is the Mountain Lion (*Felis couguar* Kerr), which formerly had a wide range almost throughout the United States. To-day it seems to be represented by about a dozen individuals in the Yellowstone Park. It has been practically killed out in the Kaibab National Park, in the Grand Cañon district, with disastrous results. In that limited area the deer, deprived of their one natural enemy, bred to excessive

numbers, so that in 1924 there were 30,000 deer in the Park ; these were dying of starvation, the grass had gone and the foliage of many of the trees was eaten away as far up as the deer could reach. In the summer of 1929 Dr. Vorhies visited the Kaibab after fifteen years in Arizona. He says: 'The scenes of destruction that I saw there will remain with me to the rest of my life if I never go back again. I do not believe that by any process at present in sight we shall reduce that deer herd in the next twenty-five years to what it ought to be reduced to, to bring that forest back. We need the mountain lions.'

At the same meeting of the American Society of Mammalogists in May 1930, Mr. Goldman, who was defending the Government Predatory Animal Control measures, said: 'The fact is that there are not nearly as many deer now (in the Kaibab) as there were in 1924. The deer reached their peak there in that year. Since then they have been reduced. But they are reducing forage at a still faster rate, and of course we do not know just what the end will be. It seems to me that it will take a good many years probably before the situation is straightened out or that the vegetation can come back in any great quantity.'

Now the point I want to make on this Kaibab experience is this. The deer themselves have suffered material damage by the elimination of the Mountain Lion. Their numbers after that event rose to a peak far beyond the capacity of the country, so that they destroyed the forest ; starvation, coupled with inactivity and over breeding, owing to the unnatural peace of their surroundings, have sapped the strength of the deer ; weakened in these ways, and now declining in numbers, they may fall to the first epidemic or first bad year that comes along and be eliminated too.

One of the chief objects of the United States Predatory Animal Control is the elimination, in the supposed interests of the sheep-breeders, of the Coyote or Prairie Wolf (*Canis latrans* Say). This animal, with the clearing of the country for the purposes of agriculture, and with the elimination of other Carnivora, has greatly extended its range in recent years. For instance, in the West, where its northward limit used to be in Alberta, it has now spread north-west into Alaska. The method adopted by the Control officials (of whom there are no fewer than 145 in Wyoming alone) is to lay a central bait of unpoisoned meat in some convenient station. From that centre long avenues formed by little baits of fat poisoned with strychnine radiate in all directions. The coyote is shy and cunning ; it never goes straight through to the chief bait, but approaches in circles. In the course of its circles it keeps

on meeting with the pieces of poisoned fat, and sooner or later yields to the temptation to try one. In this way enormous numbers of coyote have been killed; to give an idea of the slaughter, 50,000 of the bodies were recovered in the five years 1924-8 for an examination of the stomach contents. That can hardly be more than a fifth of the total killed in the same period. It is claimed that this strychnine method entails but little risk to other less destructive fur-bearing species because they usually go straight through to the fresh unpoisoned meat, and the poisoned fat-baits are collected after the coyote operations are concluded in any given district and, if lost, soon break up under the sun and become inedible. But the fact remains that many thousands of foxes, badgers, skunks, racoons, minks, and other desirable and perfectly harmless animals have been destroyed by the coyote campaign. Nobody denies that the coyote does occasionally great damage to sheep and lambs, and sometimes kills calves, colts, and even full-grown deer; but that is the work of a comparatively few individuals. The staple food of the vast majority is rodents. And the great destruction of carnivorous life which has taken place in the United States continuously from 1916 to 1930 and later has been followed by a steady and alarming rise in the rodent population. It is necessary to remark that birds too have suffered, in addition to Carnivora; thus in one year 5,000 magpies had to be poisoned as a preliminary because they interfered with traps laid for coyotes. How many other species suffered at the same time is not recorded. The only comment I will trust myself to make is that this does not seem to be quite the right way to control an occasionally destructive mammal.

Now I pass to problems of very much greater difficulty. The giants sometimes vex us, but the dwarfs threaten our existence. Rats and mice of many kinds, rabbits, and hares, squirrels, sousliks, and marmots, and many other small mammals are really terrible things when they get out of their right stations and out of control. They inflict vast annual pecuniary losses upon the entire world, and from time to time they kill humanity like flies. In ten years they may do more damage to us than all the Carnivora and Ungulata together could do in ten centuries. And the galling part of the whole business is that in the majority of cases when we suffer injury of this kind we have only to thank our own folly for all our troubles. I hasten to say that here again crude methods of extermination will not afford a satisfactory remedy. Nature is as resourceful as a woman's wit, according to Rosalind. Exterminate a species now giving us a lot of trouble because we have been careless and short-sighted, and remain

still a little careless and short-sighted, and we shall have done no more than open the door for another species to come in and plague us. Exterminate the genus, the family, the order, or even the class, and there are still hosts of beings ready to seize upon the vacant places. What the result would be no man can tell: but our last condition might very well be worse than our first. It is better by far to live with the devils you do know than with the devils you don't know.

The small mammal problem arises nearly always, and in all countries, as the direct result of human enterprise. Small mammals are not noxious things in themselves; in their right stations, in their own homes, and in proper numbers, they have their own share of the great task of running this world to perform. No instructed man can point a finger at one of them—not even at the Black Rat or the Common Rat—and say with certainty that that species ought to be exterminated. The most he can say is that it should be kept in its proper place. If we take a broad yet rather close view of the great and important group of myomorphous rodents, we shall find that all are endowed with a high rate of fecundity, that all are fond of peace, security, and plenty, and that, with very few exceptions, no matter how specialized the habits and station, all are capable of adapting themselves and of adjusting their habits to novel surroundings. They are educable to a degree, and among them the rank and file are quick to follow the lead of the more enterprising or inquisitive individuals. Of course this does not apply to all the thousands of known species with equal force. Educability is developed by experience, and the House Mouse, Black Rat, and Common Rat, which have been longest in contact with civilized man, surpass all the others at the present moment in their power of exploiting human activities and of eluding human vigilance. With these things in mind it is quite easy to see how certain once innocent species have become dangerous pests, and how species now innocent will in turn become noxious if given an opportunity. With Lady Wishfort, one is tempted to ask, 'What is integrity to opportunity'.

The high rate of fecundity (coupled with the rapid growth and ripening of the individuals) is the mainspring of the whole business. So many more are born than can possibly survive that there is in each species as it were a great driving force which impels it to colonize every accessible vacant place that will afford it harbourage and sustenance. In purely natural conditions, which, alas! now exist in very few places in the world, the food and space available for any given species of rodent are strictly limited. These limits, the presence of competitive species, the presence of all kinds of carnivorous enemies, the weather, and, in the last resort, if all

else fails, the existence of disease, form together the stern bonds by which nature keeps the species comfortably in its place. Of course, even in purely natural conditions things may sometimes go wrong. Some accident may temporarily provide the undue increase of some favourite food-plant, a competitor may be hard hit, carnivorous enemies may have been temporarily weakened, the weather unduly lenient, or disease temporarily dormant; one of these things, or some or all of them in combination, may for the time unduly favour a particular rodent, and then its numbers will rise far above the number which represents the real capacity of the area inhabited. There is, of course, too, evidence, brought together largely by Elton, of a periodicity or rhythm in the fluctuating numbers of rodents; but with that I will deal a little later, merely remarking now that in some cases, at all events, that rhythm may itself be in part due to human interference. But to whatever cause the abnormal rise in numbers may be due, nature sooner or later steps in, tightens her bonds on the species, and removes the surplus. Sometimes the cure is so sharp that after the swarm has passed away the species will become very rare on its old ground, its numbers diminished far below the normal representation. It may then take months or years to recover: and if at this moment of extreme decline an attack be made upon it, by the arrival of a strong, vigorous competitor, the advent of a hard winter, or some other adversity, it may become totally extinct.

Now when man comes along he at once deranges this natural mechanism. He cannot get at the mainspring, high fecundity, but he weakens the escapement, that is the controls devised by nature. In fact, for some quite unintentionally favoured species he has destroyed the whole escapement with the exception of the absolute limits imposed by food and space and the liability to disease. The destruction of the forests, the clearing of the ground for agriculture and sport, the cultivation of food-plants, the breeding of live stock, the building of houses and sheds, the establishment of villages, towns, and cities, the construction of roads, railways, canals, and sewers, of shipping and ports, and the development of commercial relations between all the countries of the world, have enlarged, beyond all reasonable bounds, the food and space and the shelter available for those rodents able to take advantage of such improvements. At the same time we have greatly diminished the space available for carnivorous animals of all kinds, we have relentlessly persecuted all the carnivorous mammals whose interests occasionally seemed to conflict with our own, and we have hunted every fur-bearing species in all parts of the world, wherever possible, to the point of extinction or something dangerously

close to it. By these means we have greatly weakened the rodent resistance of the country-side in all parts of the world ; and then, adding insult to injury, we discount the real value of what we have destroyed by saying, 'Of course Carnivora were never able to prevent rat and mouse plagues', basing that assertion upon observations in such notoriously over-hunted countries as Norway or North America.

But that is not all. We have been building, for thousands of years, cities in all parts of the world, and until quite recent times no attempt was ever made to make even the most important buildings rat-proof. Obviously in such places rodents are secure from ordinary carnivorous foes and from the weather. Many, of course, fall to the domestic cat and dog ; some to the ferret and rat-catcher. Many are trapped or poisoned ; but they are educable, and quick to learn how to avoid danger of all kinds. The recent great experiment of rat-proofing in this country has had a laughable but, it may be, in the end a very serious result. Comedy is never far removed from tragedy.

The House Mouse, The House Rat (*Rattus rattus*), and the Common Rat (*Rattus norvegicus*) are Asiatic species, which have wandered all over the world with man. Nobody knows when the House Mouse arrived in western Europe, but it has been in these islands at least since neolithic times. There has been a great deal of uncertainty as to whether either of the two rats was known to the ancients ; but I think the Greeks must have known both. As regards the Romans, I have put on the table three bronze statuettes from a first century A.D. site near the palace of the Caesars in Rome. These, formerly in the Martinelli Collection, were given to me very generously by the late Dr. Sambon, in gentle refutation of one of my earlier rasher published opinions. One of the statuettes certainly looks like a *Rattus rattus*, and the other (on a smaller scale) like *R. norvegicus*. What species the third represents I am not prepared to guess. They, and the fact that the Greeks trained the marten for use as a house-cat, are at any rate satisfactory evidence of the great antiquity of the rat and mouse problem in Europe. As regards western Europe, and Britain in particular, there is no doubt that the first rat to arrive was *Rattus rattus*. It came here probably about the time of the Norman Conquest or the first Crusade, and for hundreds of years, down to the beginning of the eighteenth century, it was the only rat infesting our houses and shipping. It was the species primarily responsible for the outbreak of bubonic plague, the black death which ravaged mediaeval Europe and culminated in our own great plague of 1665-6 ; and it is the species still chiefly responsible for the outbreaks of plague which occur in India

and other warm countries. The arrival here of the Brown or Common Rat (*R. norvegicus*) in the early part of the eighteenth century was a very important event. Being a much more vigorous and hardier species, one that originated on the open plains of Central Asia instead of in the forests of India and the Malay Peninsula, it was not at all dependent upon human shelter as a protection from our trying climate ; whereas *R. rattus* could not get through a single winter without our houses and other buildings. Once the Brown Rat obtained a footing in the country no means of ejecting it could be devised. It quickly spread all over the country, using the rivers and canals chiefly as its highways. From the stream side it entered the drains, and from the drains it entered the basements of the houses. Passing upwards from the basements, it went, floor by floor, up to the garrets. This triumphal progress occupied about a century ; and it resulted in the practical extinction of the relatively weak and delicate *R. rattus*. At the end of the nineteenth century the latter could only be found on our ships, where its gymnastic accomplishments gave it an advantage, and on the top floors of certain solidly built granaries and breweries in some of our large ports. In such places small and temporary colonies were formed from time to time, the Black Rats being introduced with the cargoes from grain ships. I remember the interest which an alleged Old English Black Rat excited when exhibited at a meeting of the Essex Field Club in 1899 ; it was really only a melanistic *R. norvegicus*.

In the present century we began to re-build central London. We could no longer be content with the shabby old streets in which our fathers made their fortunes ; so we built a series of great palaces, in which the seeds of bankruptcy and traffic congestion could be sown with sufficient dignity. People were rather disgusted with the Brown Rat ; they began to realize that it cost an awful lot to keep it in the millions which then infested London, and it was not really hygienic to have droves of them in the kitchens of every eating-house coming in laden with filth from the common sewers. So in these new buildings a great and a most successful effort was made to make the basements and ground floors rat-proof. To indicate the success of this experiment against the Brown Rat, I will merely tell you that in one prominent street the new buildings remain for the most part quite free from this pest, although from an adjoining older building as many as 5,000 *R. norvegicus* were taken recently in the course of six months. In the course of my nocturnal wanderings in the city I have often seen droves of them scurrying across the road from one warehouse to another in some of the less frequented lanes towards the river. Similar changes have taken place in many other British cities with precisely similar results.

We are thus shutting out the Brown Rat (*R. norvegicus*)—a step in the right direction. But in doing that we are re-opening the door to *R. rattus*. That poor creature has been clamouring to deaf ears for re-admittance to our land for a century, but in the face of its rival it could do nothing without our assistance. But at last we have done the really handsome thing. We have shut the rival out, established lovely attractive kitchens on the roofs fitted with plenty of nice open sky-lights, and we have linked up roof and roof, and bridged the horrid streets with a lovely net-work of telephone wires and cables. No primitively arboreal species could imagine a nearer approach to paradise. Every night there is a procession along these cables and over the roofs; new colonies are established in every possible place. *R. rattus* is now once more the Common Rat in many parts of our great city. To show how quickly it works:—Bankers move in to a brand new building on Monday: on Wednesday they think they have rats. During the week-end the backs are eaten off many of the new books, and on the following Wednesday the rat-catcher takes more than sixty out of the up-to-date roof-kitchen. We are thus fast getting back to the state of affairs which existed in the seventeenth century not only in London, but in many other of the larger ports. If this goes on we shall certainly be once more in peril of plague. Improved sanitation has little or nothing to do with it. The one great obstacle in the way of a recrudescence of plague is that so few people now sleep in the city: that nightly exodus means safety. But what would happen if the Black Rat were to get a footing in the crowded dock-side slums of our great ports I tremble to think. It has, fortunately, not come to that yet, and if we take care to devise means of protecting the roofs and do our best to banish the Black Rat once more from our cities the pest will be averted.

In these facts you see great biological principles at work—principles which I will not endeavour to formulate. But the rider to them would be: ‘If you create a vacancy, it is your own very difficult business to keep it vacant.’

Now I want to say something about a remarkable scheme devised originally by Mr. Rodier, primarily for the extermination of rabbits in Australia, but stated to be equally effective against rats both by Rodier himself and by his great British champion Mr. Jennison. The theory has been propounded in a series of curious circulars, many editions of which during the last twenty-five years have been distributed all over the world. Mr. Jennison has written two or three papers, his last statement on the subject being published so recently as 5 March last in the ‘Field’. As I understand the scheme it is shortly this:—You catch all the rats alive; you determine the sex,

kill the females, and liberate the males. In this way you create a superabundance of males and a great dearth of females. The males will then so pursue and harry the females that the latter will be unable to nurse their young or else will be worried to death without producing any young at all, and so the species attacked by this Rodier method will become extinct. Mr. Jennison experimented with this system for fifteen years at the Belle Vue Zoological Gardens at Manchester. There he claims to have reduced the rat population in that time by one-third by this procedure. This does not seem to be a very startling success; for if one had surrounded the Gardens with a rat-proof fence and then started an intensive campaign of ordinary indiscriminate slaughter, one might easily, in the course of fifteen years, have exterminated the lot. But I do not know how one measures one-third of the rat population. If it is by an inference drawn from the gradually declining catches in the live traps used, then I think the inference is unsound, because declining catches may indicate no more than that, as highly educable animals, the rats became progressively more and more wary. Many of the males were probably caught more than once in the earlier stages of the experiments, and their hearty dislike for Mr. Jennison and his experiments would be gradually but surely communicated to the whole colony. In the end, as Darwin once put it, only the feeble-minded rats of both sexes would go into the traps. But however the measuring was made, an apparent one-third decline would be well within the reach of the effects of educability produced in the course of fifteen years.

But the theory is open to a much graver objection. It rests on a fundamental misconception. It is assumed by Rodier and Jennison that the male rats are salacious creatures. That is entirely wrong. It is true that rats possess, like most other rodents, great fecundity, but they are not in the least salacious. Except for a few hours at regularly recurring intervals, when the females experience heat, the females have no attraction whatever for the male. At all other times males and females live together merely as comrades, without showing the slightest sign of sexual excitement or desire. They are eminently sociable animals, not given to fighting at all; so much is this the case that if you have more than three in a sack, unwounded and comfortably settled of course, you can, if you have sufficient courage, put your hand in and handle them with safety. The hand passes muster in the crowd as another comrade, and is so accepted. When a female comes on heat she is immediately covered by the nearest male, sometimes by five or six of them in succession, until heat subsides. There is a succession of shrill squeaks from the pairing couple, but there is no fighting and no combat

for the privilege like that which one sees in dogs and many other of the higher mammals. In due course the female withdraws to her nest, gives birth to her young, and within a few hours comes on heat again. On these facts, therefore, the only result of an application of the Rodier system to rats would seem to be to ensure that every female would find a satisfactory mate on every possible occasion.

It is always dangerous to argue by analogies from one class to another. On two or three occasions Mr. Jennison has cited the case of the Passenger Pigeon as an instance of the efficacy of the Rodier treatment. In his latest note he says: 'The Passenger Pigeon of the United States and Canada was exterminated through the mere chance that in collecting squabs for food many adult females and few adult males were killed; compared with their numbers, our starlings [to which Mr. Jennison would apply Rodier treatment] are as nothing.'

Now I do not believe there is the slightest evidence for the assertion that adult females were killed in such excessive numbers as to disturb the sex ratio. As everybody knows, enormous flocks of these birds used to migrate in search of food in the spring from the southern United States northwards into Canada. These flights were not on the same vast scale in every year; it was only at intervals that grand flights took place. They are known to have occurred at least as far back as the end of the seventeenth century, for we find a bishop cursing the birds as demons for the ravages committed by them on the colonists' crops near Montreal in 1687. One of the last flights, at least in eastern North America, occurred in the spring of 1869 or 1870, and of this an eye-witness account has been published in 'The Ibis' 1922 by my friend Dr. Lowe. The eye-witness, Dr. Welford, tells us how in earlier years flocks of a few hundreds or thousands used to arrive each morning in his district in Ontario. The birds were very shy and difficult to approach, and the sportsman thought he had done quite well if he bagged eight or ten in a day; as Dr. Welford put it, 'a right and left' was all you got and the birds passed on. Rarely could you get from fifteen to twenty-five birds out of the flock. But when the great flight came, in 1869 or 1870, the air was black with flock upon flock. In the pressure the birds could not maintain their shyness, and Dr. Welford bagged more than 400 on the first day before 10 o'clock in the morning. The flight went on all day, day after day, for a week, the birds darkening the sun, until the flight was over. For several years after this flights continued, but in greatly reduced numbers, and finally they ceased altogether, and the species became extinct.

Many other cases of this kind are known. Among mammals we have a remarkably close parallel in the Springbok of South Africa. Periodically the numbers of this animal would swell to amazing heights, and the ordinary food migrations were turned into floods of closely packed antelopes which swept away fences, crops, flocks, and herds as they rushed over the plains. One of these closely packed masses is said to have extended continuously through a space of country measuring 138 by 15 miles. One of the last of these great treks was seen in 1896, and of this a very good account has been published by Mr. Cronwright-Schreiner. After that the species became scarce, and had it not been for the fact that certain farmers resolved to protect it and treat it as a more or less domestic species, the Springbok would by now have become extinct. At any rate, there are no perfectly wild herds left.

Parallels are seen also among lemmings, voles, and other mice, among hares and rabbits, squirrels, and many other rodents. In all we get these periodical vast increases of numbers followed by sharp declines, during which the species become very rare and in certain conditions extinct. If extinction does not happen, the population sooner or later rises again to a peak. During the peak, creatures which, like many voles, have in normal conditions a strong sense of property or territory and a dislike for rubbing shoulders, are forced to abandon their ordinary habits and prejudices, and they become as closely packed as the dwellers in our slums or as the rats in our sewers. As food becomes more difficult to find for the ever-growing swarm, nocturnal and crepuscular species become diurnal; the most timid forms lose all shyness, so that species which normally would not let a man approach within many yards or even a mile of them (according to the perfection of their senses) now will run over him.

What is the explanation of these astonishing rises in numbers? It cannot be doubted that in some way the phenomenon is connected with nutrition; but a mere abundance of food, peculiarly suited to the development of the hormones stimulating sexual and reproductive activity, is not enough; space in which the peak can rise, favourable weather, absence of enemies and freedom from disease are all important factors. There has been much research of all kinds upon the subject of reproduction and upon the conditions which govern the fluctuations which we observe. Thus, in the last number of the 'Proceedings' of the Royal Society we find Messrs. Baker and Rawson describing their experiments on captive voles (*Microtus agrestis*); their work tends to show that if you shorten the daily period of exposure to light

from fifteen hours to nine you almost prevent reproduction in this species: it is the female which is chiefly affected. Now all this work on gonads, hormones, vitamins, light, temperature, and humidity is very ingenious and very interesting, and that it is throwing a great light on the precise mechanism by which food and environment influence the reproductive forces of animals cannot be doubted. But I do doubt very much whether it will lead to any serious modification of the great general principles which have long been recognized. It does not need a ghost from the laboratory to tell us in April that the return of the sun favours reproduction and growth.

To sum up. I think that the clearance of the world for agriculture, the cultivation of highly nutritious food plants, and the extermination of carnivorous animals and birds and other competing forms of life are the things which have led chiefly to the production of swarms of passenger pigeons, springboks, migratory lemmings, vole plagues, etc. In the Kaibab Park we saw the same thing beginning with the deer. In all these cases we are dealing with animals in their own homes, surrounded by all sorts of natural checks upon their increase which we have so far been unable to tamper with, and unable to appreciate. When we introduce new species into countries where we have done damage of the kind described, we see how real these other intangible and unappreciated natural checks are. Rabbits in Australia, musk rats in central Europe, and now, unfortunately, in Britain, rub the truth of this view well home.

Finally, man must, in order to feed himself, interfere with the face of the earth. But he should be alive to the possible consequences of that interference. In every community actions of these kinds should be guided by biological experience and opinion. Watchfulness upon the great openings which we create for enterprising animals is what is chiefly needed; we should be quick to prevent if we wish to control. And we should not attempt control by crude extermination.

After the PRESIDENT had expressed the thanks of the meeting to Mr. Hinton, a discussion followed, and Mr. Hinton replied.

Dr. FISHER said he would like to express his appreciation of the scientific value and general interest of Mr. Hinton's paper. With respect to the K.O.F. (kill only females) campaign, he believed that everyone would agree with Mr. Hinton's strictures on the sensational statements which had been circulated. He was not sure, however, that Mr. Hinton had been entirely fair to the promoters of the movement in stating that the *only* effect of an excess of males would be to ensure the immediate fertilization of all female rats ready to be fertilized. Some observations which the speaker had been

led to make during the last few years upon a colony of mice, which he had kept for genetical purposes, seemed to show that other effects would be not improbable.

For the purposes of his experiments it had been necessary that the successive litters of each doe should be sired always by different bucks. At first he had tried waiting till the litter had been born before changing the buck. But this course had been quickly found to be disastrous. Mice appeared to have a strong sense of territory, and the doe usually flew at the intruder, who, for his part, defended himself very meekly, and displayed every anxiety to escape. If, after they had settled down, they were left for the night, it was found in the morning that the litter had been slaughtered, and was being quietly eaten by both adults. It was considerably safer to introduce the doe and her litter into the buck's cage, for his infanticidal instinct appeared to be conditioned chiefly by finding himself on alien territory.

In the light of these facts the practice had been next adopted of changing the bucks before the litter was born, in fact as soon as the pregnancy could be detected, so as to give the buck introduced as long as possible to settle down, and 'feel at home' in his new surroundings. It was particularly interesting that this plan worked well for old bucks, but generally failed when a young buck was introduced into the experiment. The infanticidal instinct was, in fact, very finely adapted to the biological needs of the male mouse. If a buck, which had been capable of engendering for only ten days, were confronted with a litter which had been begotten certainly as long as nineteen days ago, calculation might show him that he could not be its father. In practice he might not do the calculation, but he did slaughter the litter.

Wild bucks certainly possessed the same instinct. Until recently, before the old cages had been replaced, the first sign of an incursion by a wild buck had been always the loss of one or more litters already born, and often, what was equally annoying, the replacement of the next experimental litter by one of obviously wild parentage. The small rodents, as Mr. Hinton had said, were undoubtedly not salacious animals. But the mice at least, in the speaker's experience, had unquestionable infanticidal instincts, and, without knowing what practical successes the method could claim, the speaker suggested that it could more fairly be judged by its success in *practice* than by the rather absurd *theories* of how it was supposed to act.

Mr. G. C. ROBSON commented on the importance of Mr. Hinton's paper from the evolutionary point of view, and enquired if Mr. Hinton knew of any good instances, among mammals, of radical changes in habits occurring as the result of over-population.

Sir SIDNEY HARMER expressed his regret that the Prime Minister and the principal administrators of the Dominions and Colonial Services had not been present to hear Mr. Hinton's admirable exposition of the possible danger of attempts to acclimatize animals in new areas. He referred to previous correspondence with the British Museum (Natural History) on the subject of the Rodier method of reducing the numbers of rats and other small mammals, and he reminded the Society of the Hooker Lecture on the Swiss National Park which was delivered in the Society's lecture-room on 15 April 1926. In this lecture Professor Carl Schroeter had made the following statement :—' The preservation of certain beasts of prey is requisite as a hygienic measure, as they kill sick animals first ; in one place foxes had been exterminated, and an epidemic amongst hares set in, so that foxes had to be re-introduced ' (Proc. Linn. Soc. 138th Session, p. 44).

The following paper was read in title :—

' Reports of an Expedition to Paraguay and Brazil in 1926-7, supported by the Trustees of the Percy Sladen Memorial Fund and the Executive Committee of the Carnegie Trust for the Universities of Scotland.—Nematoda.'
By Dr. H. A. KREIS.

28 APRIL 1932

Professor F. E. WEISS, F.R.S., President,
in the Chair

The Proceedings of the General Meeting held on Thursday, 14 April 1932, having been circulated, were taken as read and confirmed,

A list of names of those who had made gifts to the Library since the previous meeting was read and laid on the table.

Certificates of recommendation of the following candidates for Fellowship were read :—For the second time, in favour of George Francis Scott Elliot and Martin Audley Foquett Sutton ; for the first time, in favour of Raghunath Prasad Asthana and Abdus Sattar.

The cause of petaloid colouring in ' apetalous ' flowers.
By Miss E. R. Saunders.

MISS SAUNDERS stated with reference to the title of her paper that she intended ' cause ' to be taken to signify the more immediate or proximal cause, and that among plants

with 'apetalous' flowers she would include all Dicotyledon types with a single perianth.

In the greater number of monochlamydeous types the members of the perianth (conveniently indicated by the term tepals) are petaloid (coloured or white); in a minority they are green, like the sepals.

A study of the vascular anatomy of a number of dichlamydeous types showed that they could be divided into two groups. In the one group the marginal veins of the sepals are derived by lateral branching from the midrib; in the other these veins most frequently arise from commissural trunk cords, that is to say, from trunk cords which turn out from the central cylinder on the alternate or petal set of radii. Each of these trunk cords forks to furnish two marginal veins. Each carries out, conjoined with these two bundles, the midrib bundle for the petal of the corresponding radius, sometimes also, the bundle for the antepetalous stamen on that radius. As the trunk cord passes to the periphery it becomes resolved into its components, the two marginal bundles passing to the sepal to right and left respectively.

A similar investigation carried out upon monochlamydeous types showed that they likewise can be grouped into two classes. In the members of the one class the vascular system of the tepal is derived entirely from elements in the central cylinder lying within the limits of the tepal sector, the midrib being formed from elements in the centre of the sector, marginal veins (if present) arising generally as lateral branches from the midrib, exceptionally as distinct strands from elements lying alongside those giving rise to the midrib. In those of the other class the midrib is derived as before, but the marginals are commissural in origin, arising either separately or conjoined in pairs from a point or points in the central cylinder lying within the limits of the sectors alternating with those of the tepals.

It was found that in plants belonging to the first class the tepals were green (non-petaloid); in those of the second class they were petaloid (non-green). There thus appears to be a definite relation between the vascular ground-plan and the general colouring of the tepal.

A survey of the whole body of evidence leads to the further general conclusions:—

(1) That the complex of characters which are implied by the terms sepaline and petaline respectively are laid down in definite relation to time and space in the typical cyclic flower, the sepaline appearing first, the petaline later, and on radii that alternate with those of the sepals irrespective of the particular planes in which these members may lie.

(2) That the individual members of the single perianth

are not morphologically equivalent in all types. The tepals of the green perianth correspond to sepals; those of the petaloid perianth are the counterpart of a single sepal + half the neighbouring petal on either side.

Dr. A. B. RENDLE said that the correlation indicated between the colour of the perianth in monochlamydeous flowers and the course of the vascular bundles was very remarkable. He asked whether in *Deherainia* cited by Miss Saunders the green colour was due to chlorophyll, and pointed out that green petals were not invariably coloured by the chlorophyll pigment, as, for instance, in *Ixia viridiflora*, where no pigment was present.

Sir SIDNEY HARMER asked Miss Saunders whether she could explain the coloration of *Helleborus viridis*, in which the calyx is green, although it is white or coloured in certain other species of the genus.

Professor R. R. GATES expressed much interest in Miss Saunders's results, and stated that the only similar case that occurred to him, of correlation between vascular anatomy and pigmentation, was in an *Oenothera* mutation. *O. rubricalyx* appeared as a dominant mutation from *O. rubrinervis* in 1907. In the buds of the latter the midvein of the sepals (which contains a vascular bundle) is invariably green, as is also the hypanthium. In *rubricalyx* this midvein is deep red, and the hypanthium as well. This case is of particular interest, as the evidence indicates clearly that *rubricalyx* arose as a gene mutation.

Dr. T. A. SPRAGUE pointed out with reference to Miss Saunders's view that a *commissural* origin of the marginal veins of the tepals in Monochlamydeae indicated that these tepals were morphologically compound (the median part being sepaline and the margins petaline), that a similar origin of the marginal veins was found in the *sepals* of numerous dichlamydeous plants such as *Hibiscus*. Since it is generally agreed that many Monochlamydeae have been derived from dichlamydeous ancestors by loss of the corolla, such tepals might be wholly sepaline, and the hypothesis that they were partly sepaline and partly petaline seemed unnecessary. He suggested that useful evidence might be afforded by the study of monochlamydeous members of characteristically dichlamydeous groups, e.g. *Chrysosplenium*, in the Saxifragaceae.

The PRESIDENT, in thanking Miss Saunders for her interesting communication and exhibits, considered the results arrived at to be of fundamental importance. If the views put forward proved to have a more general application they might considerably modify accepted interpretations of floral

morphology. He hoped Miss Saunders would extend her observations to other groups of plants.

Dr. E. N. MILES THOMAS asked whether Miss Saunders had considered the application of experimental treatment, as, for instance, the severing or plugging of the commissural veins associated with coloured apetalys.

Miss SAUNDERS replied.

On the alleged larvicidal property of *Chara fragilis*.

By Mr. T. B. Blow.

FROM the 'American Journal of Hygiene', vii (1928), p. 279, it appears that Messrs. Matheson and Hinman began a series of observations on *Chara fragilis* in connection with mosquitos in 1923, and commenced the tests in 1925.

Further tests were made by these workers, the results being published in the 'American Journal of Tropical Medicine', ix (1929). Without going into details of the very extensive tests applied, it may be stated that their conclusions were that '*Chara fragilis*, growing in still- and running-water aquaria of various kinds, prevented mosquito breeding. In the presence of decay oviposition takes place, and larval development proceeds normally. If the plant recovers its vigorous growth the decay ceases, larval growth is inhibited, and oviposition does not take place'.

These conclusions came as a great surprise to British investigators, who had used many species of Charophyta as tests (in my case six species). None of them, however, appeared to have tested *Chara fragilis*, though I had used, with negative results, *C. delicatula*, a very near relative of *C. fragilis*, of which some botanists regard it as a subspecies. Thanks to the kindness of Colonel Barnardiston, I obtained an ample supply of *Chara fragilis* proper, and when it had grown vigorously in two of my large glass jars introduced larvae of *Culex pipiens* and *Theobaldia annulata*; they enjoyed a vigorous life, between 80 and 90 per cent assuming the winged state.

It will be remembered that Mr. Pal, in his paper on Charophyta of Burma, read before the Society on 22 January 1931, drew attention to the destruction of mosquito larvae by predatory insects. I sent a copy of the abstract of Mr. Pal's paper to Dr. Hamlyn-Harris, the City Entomologist of Brisbane, Queensland, whom I have known for many years as a careful investigator of this subject, and of *Chara fragilis* in particular, and the following is a copy of a letter sent to Mr. Pal:—

'Some little time ago Mr. T. B. Blow of Welwyn sent me your abstract on Burmese Charophyta, read before the Linnean Society of London, and I thought the following notes

might interest you. Some recent experiments with *Chara fragilis* have interested me very much, and have some bearing on the economic importance of your own investigation. Some time ago I instituted a number of experiments with jars containing:—(1) *Chara fragilis* growing normally, and (2) *Chara fragilis* in the state of decomposition, (3) *Hydrilla* and *Ceratophyllum*, (4) *Nitella gelatinosa*. Though these jars were all situated within a few feet of one another, the extraordinary thing is that the first jar to be selected was a large earthenware vessel, containing about a gallon and a half of water, and a fine growth of *Chara fragilis*. The mosquito to select it was *Aedes argenteus*, of which the first three pupae hatched within a period of ten days. Then came a further surprise: *Culex fatigans* selected a glass jar containing a smaller quantity of water, but a more luxuriant growth of *Chara fragilis* than was contained in any of them. Two egg-rafts were laid on this water. Some hatched out into adults quite normally, but the greater majority of larvae fell a prey to, first of all, the attacks of the species of *Hydra* present in considerable numbers; the young larvae could be seen quite distinctly inside the central cavity when viewed in certain lights: secondly, the remainder of the first egg-raft was attacked by a species of *Saprolegnia*, which killed off the larvae so attacked. None of the other jars, not even the controls, were selected. It does seem strange to think that these two jars should have been the only ones selected, and in face of such facts how can I possibly accept Matheson and Hinman's statement that "under every condition *Chara fragilis* is larvicidal". I never make these observations without showing them to responsible people, so that they are able to judge for themselves. In this particular instance my witness was Dr. Graham Drew, the Deputy Commissioner of Public Health, Queensland.'

I may here note that Dr. Hamlyn-Harris has several articles on the subject in the 'Proceedings' of the Royal Society of Queensland, notably in vol. xli, no. 3, in which he gives a long account of the various predatory insects which prey on the Mosquito larvae.

In a later letter to me Dr. Hamlyn-Harris said:—' My latest researches into the efficiency or otherwise of the Charophyta as possessing larvicidal property only confirmed what I said all along. To my mind they are utterly useless in mosquito control. In the laboratory conditions are so abnormal that one finds that they breed sometimes, and sometimes they do not; but I have proved experimentally that by providing supplemental food *Culex fatigans* can be induced to breed in overwhelming numbers. I am further of opinion that Professor Matheson's interpretations of his

findings are inadequate, because he has entirely ignored certain chemical phases of the question which may be responsible for the conditions which he obtained, such as the decrease of CO_2 , the increase of carbonate due to the temperature of water, according to the time of day; therefore I do not believe that the Characeae have anything to do with the conditions which he attributes to them. This briefly, in a nutshell, is, I fancy, all you need to know. If you require any further information, please write, and I will communicate with you further on the subject.'

I think from what I say in this paper about *Chara fragilis*, and with the corroborative evidence of Dr. Hamlyn-Harris, that it may safely be concluded that that species, in common with Charophyta collectively, has no larvicidal qualities.

Mr. G. FOX WILSON, with reference to the reputed toxic action of certain species of *Chara* on mosquito larvae, pointed out that an interesting statement is made by John Lindley in 'The Vegetable Kingdom' (1847, p. 28), viz.: 'The fetid effluvium arising from them (i.e. *Chara* growths) is regarded as very unhealthy, and one of the sources of the malaria of the Campagna of Rome'.

McGregor in 1924 ('Parasitology', vol. xvi, pp. 382-7) tested the effect of *C. foetida* and *C. hispida* on the development of mosquito larvae. These two species are said to possess distinct larvicidal properties, though this was not found to be correct.

While engaged in anti-malarial work in the Suez Canal area in 1917, it was observed that a favoured habitat of Anopheline larvae (*Anopheles pharoensis* Theobald) in Lake Kasa, west of Kantara Station, was amongst the matted growths of *Chara* (*polycantha* Braun.?). This lake was fed by an overflow from the Sweet-Water Canal, about three miles south-west of Kantara, and was connected with the larger Lake Menzaleh, whose waters are brackish. The waters of Lake Kasa are fresh, the salinity expressed in terms of parts of common salt per 100,000 varied between 1.74 and 2.91 (2.27 mean). The period of active growth of the *Chara* weed was from August to November (1917 to 1918).

The lake abounded in larvivorous fish, particularly 'Bolte' (*Tilapia nilotica*), but they were unable to approach the Anopheline larvae by reason of the impenetrable mass of *Chara*, while many fish were actually trapped amongst the growths. These fish were found to be useless for destroying mosquito larvae, not only amongst the masses of *Chara*, but they also failed to clear the larvae from areas of reeds—*Phragmites communis* and *Typha* spp. These fish were useful, however, under artificial conditions. For instance,

camel tracks situated by the lake-side became flooded, and in them mosquito breeding was intensive. It was a simple operation to form channels from the lake so that fish had free access to the tracks, with the result that the larvae, unprotected as they were by vegetation, were eaten with avidity.

The whole question whether *Chara* possesses any larvicidal properties is not clear, though it is certain that some species are devoid of any toxicity.

Great care must be exercised in carrying out tests, especially under laboratory conditions, for it must be remembered that certain mosquito larvae prefer water with an acid reaction, others with an alkaline, while others show greater tolerance and live equally well in both acid and alkaline waters. Laboratory conditions are not always ideal for the breeding of mosquitoes, and more conclusive evidence is required before this matter as to the toxicity of *Chara* to mosquito larvae is cleared up entirely.

The PRESIDENT expressed his interest in Mr. Blow's communication, and stated that the further observations made by Mr. Fox Wilson in Egypt confirmed Mr. Blow's opinion that there was no larvicidal quality in *Chara*. On the contrary, *Chara* would seem sometimes to prevent the destruction of the mosquito larvae by fish.

Mr. J. RAMSBOTTOM commented on Mr. Fox Wilson's point about laboratory conditions. It was stated in Dr. Hamlyn-Harris's letter that *Saprolegnia* killed some of the larvae. This was a common experience in the laboratory of the Anti-Malarial Unit at Salonika, though it could not be said that *Saprolegnia* in the wild had any apparent influence in limiting the myriads of mosquito larvae.

Biology of the African Lakes.

By Dr. E. B. Worthington.

THE lecture was intended to introduce the scientific results of the Cambridge Expedition to the East African Lakes, which are to be published as a series of papers in the Society's Journal.

Rifting and warping movements of the earth's crust, volcanic activity, and the pluvial periods, which were contemporaneous with the European glaciations, have done much to change the drainage systems of East and Central Africa. One of the objects of the expedition was to help to disentangle these geological questions by evidence from the distribution of aquatic fauna and flora, both living and fossil.

Originally Central Africa was a simple dome or geanticline, its summit about the present east shore of Lake Victoria, with streams running east to the Indian Ocean, the remnants

of which are the Tana and Athi Rivers, and westward across Uganda to the Congo, and so to the Atlantic, the remnants of which are a series of rivers between Lakes Edward and Victoria. These have been partly reversed by the sinking of the Lake Victoria depression, and now arise in swamps, and flow in both directions, east to Lake Edward and west to Lake Victoria.

The White Nile has now two important sources—Lake Victoria via the Victoria Nile, and Lake Edward via the River Semliki, but evidence was adduced to show that Lake Edward was completely dried up during the arid interpluvial period. This desiccation caused the extinction of the old Edward fauna, and accounts for the fact that crocodiles, Nile perch, &c., no longer exist in that lake. The modern fauna of Lake Edward is considered to have been derived mostly from the east, from Lake Victoria, during the second pluvial period, and the faunistic distribution is in favour of this hypothesis. For instance, the expedition's collections have shown that there is one species of *Barbus* common to Victoria, Edward, and Kivu, with subspecies in each lake. Lake Kivu now drains into Lake Tanganyika and the Congo, so that this piece of evidence corroborates the geological conclusion that Lake Kivu formerly drained north to Lake Edward and the Nile, until the growth of the Mfumbiro volcanoes ponded the valley and caused it to overflow to the south. The eastern Rift Valley lakes now lie in closed drainage basins, but the fauna and geology of Lake Rudolf show it to have been connected to the Lower Nile during the pluvials.

Passing to ecological results, two lakes were taken as examples. Lake Bunyoni, a very modern lake in Uganda, has no indigenous fishes, but in their absence frogs (*Xenopus laevis*) have taken to a pelagic existence, feeding on planktonic Crustacea and themselves eaten by otters and fish-eating birds. In an old lake, such as Rudolf, on the other hand, there is a complete food-chain from the phyto- and nanoplankton which depends on chemical and physical factors in the water, through Crustacea, pelagic fishes (*Engraulicypris*, sp. n.), and tiger-fish, to the Nile perch, crocodiles, and man.

Dr. G. D. HALE CARPENTER said that the Sitatunga antelope (Speke's Tragelaph) on the Sesse Isles of Lake Victoria was of very great interest. Since the removal of the inhabitants of the archipelago at the close of the last century the antelope, without any enemies to check it, had multiplied so prodigiously that by its browsing it had completely changed the character of the forests in some parts. (Photographs were shown, taken in 1926, of a typical forest scene where sitatunga had not been feeding, and another where the undergrowth had been

so browsed that bare ground and dead leaves could be seen.) During the war an American entomologist, Mr. W. F. Fiske, who was investigating tsetse fly on the islands, had said that the great increase in numbers of the buck had led to some kind of skin disease, and that he had found it difficult to obtain a perfect skin. This may have been due to dietetic deficiency, the favourite plants having been eaten down. The island specimens of this antelope live much like Bush-buck; it is usually found among papyrus, being apparently a form of Bush-buck modified for life in swamps, the hoof being more deeply splayed and longer. But on the islands it lives among the forests, and may be seen browsing where forest and grass-land meet. It was the opinion of Meinertzhagen that the island specimens were a distinct subspecies (P. Z. S. 1916, pp. 375-81).

The great increase in numbers of this animal, and the alteration in the character of the undergrowth, had had an effect upon the insect life. The numbers of *Glossina palpalis* (the species of tsetse fly abundant on the islands) seemed to have been affected by the more open character of the forests. Dr. Carpenter had found the numbers much less in 1925, on a single visit, than they had been during 1912-13, when he had resided on one island for fourteen months continuously. The butterfly fauna appeared also to have been affected. Butterflies of the nymphaline genus *Precis* on the Sesse Isles exemplified in a remarkable way the effects of climate. Species of this genus are well known to appear in different forms according to the season: the dry-season forms were formerly considered to be different species from the wet-season forms. But on the Sesse Isles the climate is more uniform than on the mainland: there is no month without some rainfall, and during the twelve months when Dr. Carpenter took records on Bugalla Isle there were about ten inches more rain than on the mainland, twenty miles to the north. The point is that all specimens save one of *Precis archesia*, an abundant insect, which Dr. Carpenter saw, were of the extreme wet-season form: the one exception was transitional to the dry-season form. *Precis sesamus* occurred in both forms, but the pink wet-season form was far more abundant than the blue dry-season form.

Dr. Carpenter said that the fishing industry on Lake Victoria, with which Dr. Worthington had dealt, had been a matter of grave concern to himself as Specialist Officer for Sleeping Sickness in Uganda. Fishing involved close contact with the tsetse fly which haunted the forested shores. Dr. Lyndhurst Duke, of the Human Trypanosomiasis Institute at Entebbe, considered that since the depopulation of the

islands, the prolonged exposure of the sitatunga to *Trypanosoma gambiense*, introduced into them by the tsetse, had resulted in loss of power of the trypanosome to live in man. After the war, over 2,000 fishermen, under careful regulation and subject to frequent medical examination, were allowed to resume fishing in their former manner. This experiment on a large scale proved completely safe: no one contracted sleeping sickness, and the islands were partially re-opened to inhabitants, under control. When Dr. Carpenter left Uganda in 1929 no case of sleeping sickness had developed, although over 6,000 people were residing on the islands, and all fishermen were constantly being bitten by *Glossina*. Great watchfulness, however, was required in case the human strain of trypanosome was re-introduced to the fly by a visitor: in these days of free communications natives from the Congo were often found in Uganda. International reciprocity was urgently needed in the control of sleeping sickness; and any measures for encouraging the supply of fish to native populations must always be framed with due regard to prevention of an epidemic of sleeping sickness.

Dr. W. A. CUNNINGTON congratulated the speaker on his lecture, and expressed the opinion that scientific results of great interest must follow from the detailed study of these African lakes. He enquired whether the results of his recent investigations would lead Dr. Worthington to predict the absence of living forms at a considerable depth in the much deeper lakes—such as, for example, Nyasa and Tanganyika.

Dr. WORTHINGTON, in replying, said that *Clarias carsoni*, introduced to Lake Bunyoni in 1919, has had little effect on the ecology of the lake, since it is restricted to the inshore weedy areas. The wholesale death of Nile perch is still a mystery. With regard to the conditions in deep water, all lakes so far examined have sufficient oxygen down to the bottom, with the exception of Edward, where there is a pronounced chemical thermocline at 60–80 m. The conditions in Lakes Tanganyika and Nyassa have yet to be examined, though there is some evidence to show that no thermocline exists as far down as 400 m. The abyssal fauna, if any, awaits discovery. In paying a tribute to Dr. Cunningham's Tanganyika expedition of 1904, the hope was expressed that a further expedition might be arranged to solve the deep-water problems.

The PRESIDENT closed the meeting with a vote of thanks to Dr. Worthington.

12 MAY 1932

Professor F. E. WEISS, F.R.S., President,
in the Chair

The Proceedings of the General Meeting held on Thursday, 28 April 1932, having been circulated, were taken as read and confirmed.

A list of names of those who had made gifts to the Library since the previous meeting was read and laid on the table.

Certificates of recommendation of the following candidates for Fellowship were read :—For the second time, in favour of Raghunath Prasad Asthana and Abdus Sattar ; for the first time, in favour of Irene Alexandra Francis Hilton, Kurumthottical Cherian Jacob, and Thomas Kenneth Rees.

The following candidates were balloted for and elected Fellows :—Benjamin Peary Pal, M.Sc., David McCall, B.Sc., Ph.D., Robert John Flintoff, The Right Hon. The Earl of Cranbrook, George Francis Scott Elliot, M.A., B.Sc., and Martin Audley Foquett Sutton.

The following candidates were balloted for and elected Foreign Members :—Professor Klas Robert Elias Fries, Professor Eduard Fischer, Professor Ludwig Jost, and Professor Emile Topsent.

Mr. J. W. BODGER exhibited a specimen of *Scrophularia vernalis* from Northamptonshire.

Summary and general conclusions regarding the insect fauna of the Seychelles and adjacent islands. By Dr. Hugh Scott.

THE insects collected by the Percy Sladen Trust Expedition to the Indian Ocean under Mr. (now Professor) Stanley Gardiner in 1905 and 1908–9 have all been worked out, and eighty-two systematic reports, by fifty specialists, have been published. As the results of previous collecting have also been taken into account, these conclusions are based on the total fauna known from all the islands.

2,426 species have been enumerated, and 1,423 described as new to science. The problem is not, however, that of a single insular fauna, but of several ; on the one hand, the mountainous granitic islands of the Seychelles, standing on a submerged bank some 12,000 square miles in extent, within the 100-fathom line ; on the other, several separate groups

of coral islands (Chagos, Amirantes, Coetivy, Cargados, Farquhar, and the Aldabra group), some standing on shallow submerged banks, others rising separately from great depths. Of the known fauna, 2,090 species are recorded from the Seychelles, 537 from all the coral islands taken together, and only 202 species are common to both the Seychelles and the coral islands. Among the latter, Aldabra and its neighbours have over 300 recorded species, and the Amirantes and Chagos archipelagoes are next, with about 90 species apiece.

The insects of the coral islands, mostly more or less widespread forms, belong to several zoogeographical categories. As might be expected from their situation, the northern and north-eastern archipelagoes (especially the Chagos) have a larger proportion of Indo-Australian species, while the African and Madagascan elements increase as one passes to the south-west, being overwhelmingly strong in the Aldabra group. Nearly all the coral islands, however, possess some species unknown elsewhere. The Aldabra group has twenty-six Coleoptera, and some other insects, believed to be endemic. Otherwise the potential endemics are very few. Excepting, possibly, some curious cases, such as a genus of wingless crickets represented by one species in the mountains of the Seychelles, and another in the Chagos, they are all probably explicable as the descendants of ancestral immigrants which reached the coral islands across the sea.

The Seychelles, on the other hand, have long been considered as not true oceanic islands, but as the remains of a much larger land, possibly directly connected with India and Africa, the latter either through or independently of Madagascar. An attempt is made to test this theory by comparing their fauna with that of a purely oceanic archipelago, for which purpose the volcanic Hawaiian islands are chosen. A comparative table shows the numbers of species and genera of the various orders recorded from the Seychelles and the Hawaiian islands, and the proportion of endemics in each order. A column is added showing the approximate numbers of species for the British Islands, which, situated very close to a continent, and in north-temperate latitudes, offer a strong contrast to the two remote tropical archipelagoes.

Several conclusions emerge on examination of this table. The Seychelles, with a land-area of less than 160 square miles, have 2,090 recorded species, of which over 1,300 are unknown elsewhere; the Hawaiian islands, area about 7,000 square miles, had (when the 'Fauna Hawaiensis' was completed in 1913) 3,115 species, of which over 2,700 are endemic, a number estimated as about half the existing endemic fauna;

the British islands, area about 121,000 square miles, have over 20,000 species on a conservative estimate. While the figures show over 80 per cent of the Hawaiian species as endemic, in the Seychelles about 65 per cent are possible endemics, but this percentage will probably be somewhat reduced by the discovery in other countries of some species hitherto unknown elsewhere. As to the proportions of the numbers of species in the different orders, Coleoptera are far the most numerous in both the tropical archipelagoes, a condition which may not be entirely due to the chances of collecting; but in Britain they are heavily outnumbered by both Diptera and Hymenoptera, two orders which are, so far as known, of less antiquity.

Certain orders, such as the palaeontologically very ancient Plecoptera and Mecoptera, are unrepresented in both the tropical archipelagoes. On the other hand, Ephemeroptera and Trichoptera, though quite unrepresented in the Hawaiian islands, have endemic representatives in the Seychelles. The former are believed to extend back to the late Palaeozoic, the latter at least to Jurassic times. Such fragile insects are unlikely to have immigrated over wide stretches of sea, and their presence may be an indication of ancient continental conditions.

A much greater number of families and genera are represented in the Seychelles, both actually and in proportion to the total fauna. The average is less than two species per genus, while in the Hawaiian fauna it is nearer five per genus. The Hawaiian fauna includes numerous 'endemic complexes', i.e. large endemic genera containing many closely related species, a rare phenomenon in the Seychelles. In the Coleoptera alone sixty families are represented in the Seychelles, and forty-five include some endemic species; in the Hawaiian islands only forty-seven families are represented, and the endemic forms are restricted to eighteen families. Only two families are represented in the Hawaiian islands which are unrepresented in the Seychelles, but fifteen families are represented in the Seychelles which have no representative in the Hawaiian islands.

These phenomena appear to indicate that (a) while relatively few ancestral immigrant species have succeeded in crossing the ocean and establishing themselves in the Hawaiian islands, they have given rise to large numbers of descendant species, with a resulting very high percentage of endemism in the fauna; and (b) the Seychelles fauna is the remains of that of an ancient continental or subcontinental land, isolated long enough to have a high percentage of endemic forms, but not so high as in the purely oceanic Hawaiian group.

The endemic fauna of the Seychelles seems to have developed throughout the archipelago as a whole, with little segregation

of distinct forms in the separate islands. The islands may, therefore, have been sundered from each other comparatively recently. The fauna also seems to have been stabilized long ago, with no continuation of species-formation down to recent times, such as has apparently taken place in the Hawaiian archipelago. These conclusions agree closely with those of Summerhayes regarding the flora. The principal change in recent times has, doubtless, been the extermination of many endemic species.

Sections are devoted to local island races of non-endemic species, the reduction or atrophy of wings and eyes in certain species, the smallness and dull colouring (both relative and actual) of most of the endemic insects, and the association of certain members of the fauna and flora. Over seventy species, mostly endemic, and representing twenty-eight families, were found in the spaces between the leaf-axils of endemic palms and *Pandanus*. About one-third of these were not found elsewhere. With other small invertebrates from the same habitat, they probably constitute the longest list of dwellers in leaf-axils from any country in the Old World.

Condensed zoogeographical reviews of the orders are given, and the endemic fauna is analysed. Some few forms appear to be taxonomically isolated, an overwhelmingly large number have Indo-Australian affinities, and others have, respectively, Madagascan, Mascarene, and African affinities (the term 'Mascarene' is restricted to groups centred in the volcanic Mascarene islands and absent from, or weakly represented in, Madagascar). This result, arrived at independently, tallies well with the recently published analysis of the flora. Such a blend is much what might be expected on the hypothesis that the Seychelles are of ancient continental origin. Whether the former land-connexions were 'bridges' in the older sense, or owed their existence and subsequent disappearance to the displacement of the continental land-masses, is a problem beyond the scope of this paper. But assuming the Seychelles to have been connected with Asia and Africa, their isolation must have been brought about very long ago, or they could hardly exhibit so high a degree of endemism in their fauna and flora. There are slight faunistic indications that connexion with Africa may have persisted later than that with Asia, possibly to early Tertiary times, and that the connexion with the two continents need not necessarily have included Madagascar. Suggestions are put forward to explain a puzzling fact, viz., that many of the endemic insects with eastern affinities have their nearest relatives, not in Ceylon and India, but in the Malay Archipelago, or even further south-east, in Australasia and on the confines of the Pacific.

The PRESIDENT having expressed to the author the thanks of the meeting, Professor J. STANLEY GARDINER pointed out that the communication was by far the most important geographical paper, from the point of view of insects, presented since R. C. L. Perkins gave his account of the Hawaiian islands; that the other groups of land-animals support Dr. Scott's view; also, to a lesser degree, plants. Furthermore, as to the coral islands, they are modern, merely 3-5,000 years old, and the most interesting feature is the small number of their insects compared to plants—about equal numbers—whereas one plant should carry on an average six insects.

Botanical exploration on the Burma-Tibet frontier. (Lecture.)
By Captain F. Kingdon Ward.

S.E. ASIA from Assam to Annam is a big peninsula almost as much cut off from the rest of Asia as is the Indian peninsula. It differs from the Indian peninsula in one important respect: it has never been completely severed from the mainland of Asia, certainly not in Tertiary time. The southern end of this peninsula has, however, been broken up more than once, giving us the Malay Archipelago. Thus the south-eastern peninsula belongs to Asia even more than the Indian peninsula does, and its past is wrapt up in the past of Asia generally.

A physical map of Asia shows two mountain systems crossing each other, or, perhaps, merely meeting, almost at right-angles. Both are formidable physical barriers, the Himalayan system forming the boundary between the Indo-Malayan and Central Asiatic floral regions, the Sino-Malayan system forming the boundary between the Indo-Malayan and Eastern Asiatic floral regions.

But great mountain systems are also highways of migration. The Himalayan ranges are not only a barrier between north and south, but also a link between east and west. The Sino-Malayan ranges are not only a barrier between east and west, but also a link between north and south. And both together have evolved an alpine flora largely endemic.

In any attempt to unravel the distribution of animals and plants in S.E. Asia two problems present themselves for solution:—

Which of these two mountain systems has had the greater influence on distribution in S.E. Asia generally? (1) In so far as they act as barriers, is the Indo-Malayan region more cut off from the Central Asiatic region, or from the East Asiatic region? (2) In so far as they act as highways, are we to seek an extension of the Himalayan flora to the east, from the Brahmaputra to the Yangtze, thence across China to Japan and Formosa? Or are we to seek it to the south, through

the Malay Peninsula, and thence to the islands of the Malay Archipelago? The facts point to an east-west distribution rather than a north-south distribution, at least so far as the flora is concerned.

This requires explanation, for the facts also point to the Sino-Malayan ranges being much older than the Himalayan ranges; thus the former had a long start, both as barriers and as highways. They existed when the sea covered the plains of India, and much of southern Tibet also, long before the Himalaya were uplifted. In Cretaceous times these Sino-Malayan ranges were merely the west coast of the peninsula, and the only possible line of migration was north and south; nor could the system have been a barrier, since all to the west and north-west was sea, and peninsular India was an island.

Not until Oligocene or Miocene times, after the Himalaya had been uplifted, could there have been any extensive east-west migration, and all our problems of distribution really date from then; that is to say, they are, geologically, modern problems. But whatever may have happened between the Oligocene and the Pleiocene, an event was to take place subsequently to which I think far too little attention has been paid by naturalists. That event was the late Pleistocene glaciation of S.E. Asia. The reason why this has not received the attention it deserves is probably because the glaciated area is a detached one, lying right outside the polar ice-sheet area, to which attention has been mainly directed. Yet during the last maximum advance of the ice, a vast area in the Himalayan and Sino-Malayan mountains, as well as in western China and in Tibet, was covered by ice, and the effects were tremendous.

If we assume, as I think we must, that the Himalayan glaciation was contemporaneous with the Pleistocene glaciation of Europe, then we need not look back more than half a million years to account for all the greater migrations in S.E. Asia; indeed, we need not look back more than about 50,000–100,000 years, to the last great fluctuation. This ice-sheet, which spread over the high mountains of S.E. Asia, had a two-fold effect:—(i) It isolated the entire Indo-Malayan region from the Central Asian, and likewise cut off the East Asiatic region from the Central Asian; though it did not prevent a mingling of East Asiatic and Indo-Malayan forms in the south-east. (ii) It extinguished, or drove southwards, the alpine flora which had already established itself. The southern drive of the flora must have had a telescoping effect, crowding the alpine on to the subalpine, the subalpine on to the warm temperate, and so forth. The return of the flora, as the ice retreated again, must have been a very different

matter. There was ample room now ; plant did not compete with plant so much as with external conditions.

In 1932 we reached a point approximately 28° 30' North, 98° 0' East, at the sources of the Irrawaddy, on the Burma-Tibetan frontier. The country explored consists of a series of high rocky ranges, running more or less north and south, separated by deep river-gorges: the whole covered with forest to a height of about 12,000 ft. Above 12,000 ft. there is only thick scrub, and above that again, between 13,000 and 14,000 ft., dwarf scrub and scattered alpine plants.

The forest belt may be conveniently divided into (i) sub-tropical jungle, up to 3,000 ft.; (ii) hill jungle, 3,000 to 6,000 ft. away from the neighbourhood of the snowy ranges; (iii) temperate rain forest, 5,000 to 8,000 ft., close to the snowy ranges; (iv) Conifer-Rhododendron forest, 8,000 to 10,000 ft.; (v) *Abies* forest up to 12,000 ft.

In the hill jungle occur several species of *Begonia* showing affinity with Malayan species, also a *Cypripedium* related to *C. Argus*, a Phillippine Island species.

In the temperate rain forest about a third or a quarter of the tree species are deciduous. The affinity is rather with the Himalaya and China. Unexpected discoveries were *Cercidiphyllum japonicum* and *Stachyurus praecox*, known from Japan and central China, and *Pentaptyxis stipulacea*, known from Sikkim. There are numerous species of *Rhododendron* and other Ericaceae, Lauraceae, Araliaceae, Rosaceae, and Magnoliaceae; species of *Acer*, *Quercus*, *Ilex*, and *Salix*. The Conifer-Rhododendron belt is mainly evergreen, consisting largely of *Pinus excelsa*, *Tsuga Brunoniana*, *Picea Morinda*, and *Larix tibetica*; species of *Ilex* and evergreen Oak; and several species of *Acer*. The Rhododendrons grow socially, often forming forests almost by themselves. The Sikkim *Magnolia globosa* grows here.

In the alpine zone the affinity is very distinctly with the Himalayan and Chinese ranges to east and west; and, in so far as species are endemic, they are endemic on the Sino-Himalayan and Sino-Malayan ranges, considered as one plant area.

The most prolific genera are *Rhododendron* and *Primula*, *Pedicularis*, *Saxifraga*, *Polygonum*, and the endemic genus *Cremanthodium*. Typical northern temperate families, such as Ranunculaceae, abound not only in genera, but in species and individuals; and the universally successful Compositae are represented by incredible numbers, representing a large number of genera and species. The endemic genus *Nomocharis* is represented by two or three species of restricted range, and one—*N. nana*—which ranges throughout the area. There are half a dozen species of *Meconopsis*, a genus almost

completely confined to Sino-Himalaya, one species being locally endemic. *Gentiana*, *Cyananthus*, *Impatiens*, *Corydalis*, *Potentilla*, *Allium*, are all well represented.

Mr. I. H. BURKILL asked if Captain Kingdon Ward had not observed more distinct signs of the wearing out of the south-west monsoon in his Rima exploration of 1928 than in his new exploration, saying that the beautiful pictures of vegetation thrown upon the screen suggested this.

Captain KINGDON WARD replied that he did not think so.

A vote of thanks to Captain Kingdon Ward was conveyed by the President.

The following paper was read in title :—

‘ Reports of an Expedition to Paraguay and Brazil in 1926–7, supported by the Trustees of the Percy Sladen Memorial Fund and the Executive Committee of the Carnegie Trust for the Universities of Scotland. Arachnida from the Paraguayan Chaco.’ By H. D. BADCOCK, M.A. Oxon, F.Z.S.

24 MAY 1932

Anniversary Meeting

Professor F. E. WEISS, F.R.S., President,
in the Chair

The Proceedings of the previous meeting, held on Thursday, 12 May 1932, having been circulated, were taken as read and confirmed.

A list of names of those who had made gifts to the Library since the previous meeting was read and laid on the table. A special vote of thanks was accorded to the Rev. Canon G. R. Bullock-Webster for the donation of a valuable collection of pamphlets on the Characeae.

The following Fellows signed the Obligation in the Book of the Charter and Bye-Laws and were admitted :—Benjamin Peary Pal and William Borlase.

Certificates of recommendation of the following candidates for Fellowship were read :—For the second time, in favour of Irene Alexandra Francis Hilton, Kurumthottical Cherian Jacob, and Thomas Kenneth Rees ; for the first time, in favour of Mohamed Eweis.

The following candidates were balloted for and elected Fellows :—Raghunath Prasad Asthana and Abdus Sattar.

The Treasurer presented his Financial Report and the Accounts of the Society, duly audited, for the year 1931-2. On a motion by Professor W. Garstang, seconded by Mr. H. N. Ridley, the Report and Statement of Accounts were adopted.

The Bye-Laws regulating the Election of Council and Officers having been read by the Assistant Secretary, the PRESIDENT declared the Ballot for Council and Officers to be open, and voting began. The Ballot for Council was closed at 5.30 p.m. and for Officers at 6.0 p.m.

Meanwhile the Librarian and Assistant-Secretary presented his Report as follows :—

LIST OF THE SOCIETY.—Since the last Anniversary Meeting the Society has lost forty-four members. The detailed statement is as follows :—

15 Fellows by death :—José de Campos Novaes, Thomas Ford Chipp, George Claridge Druce, Percy Groom, Charles Osborne Smeathman Hatton, James John Joicey, Robert Patterson, Henry William Potts, Joan Beauchamp Procter, George Michael Ryan, John Donnell Smith, Sir William Somerville, Edward Step, John Henry Tull Walsh, Herbert Bennett Williamson.

1 Associate by death:—Andrew Scott.

3 Foreign Members by death:—John Isaac Briquet, Hans Oscar Juel, Richard Wettstein von Westersheim.

16 Fellows by Withdrawal:—Rakhal Das Bose, Sahay Ram Bose, Ernest Brown, Henry James Davies, Charles Cuthbert Eley, Charles Ethelbert Foweraker, Grace Frankland, Alice Hibbert-Ware, Cecil Henry Hooper, Lilian Mary Joy, Valavanur Subramania Kuppaswamy, James Eustace Radclyffe McDonagh, Henry Goland Robinson, Lekshminarayanapuram Subramania Subramaniam, Jacques de Vilmorin, Evelyn Janie Welsford.

9 Fellows by Removal:—Richard Siddoway Bagnall, Francis Boothroyd, Joseph Calvert, John Clark, Frank Cornish, Basant Lal Gupta, Manaranjan Mitra, Eugenie Sachs, Walter Sidney Stevens.

During the Session 4 Foreign Members and 31 Fellows have been elected. Of the 31 Fellows elected, 25 have qualified. Also 8 Fellows have qualified who were elected at the end of last Session.

The present number on the List of Fellows is 757, with 8 Fellows elected but not yet qualified.

Between 1 May 1931 and 30 April 1932 the increased cost of a large number of the serial and periodical publications has restricted the purchase of new books to one half-dozen, but several authors have generously helped the Library by the presentation of their recent works. In all, 157 books and pamphlets were presented.

During the same period 1,054 volumes were borrowed by 177 Fellows and Associates. In addition, the National Central Library borrowed 237 volumes. On the other hand, the Society borrowed on behalf of Fellows and Associates 7 volumes from the Science Library and 7 volumes through the National Central Library.

984 signatures were recorded in the Library Visitors' Book, exclusive of 80 on Saturday afternoons.

At the conclusion of the Assistant-Secretary's report, the PRESIDENT appointed Mr. H. N. Ridley, Mr. D. J. Scourfield, and Mr. A. W. Sheppard as Scrutineers of the Ballot.

The PRESIDENT then called upon Professor E. S. GOODRICH, M.A., LL.D., F.R.S., who had been selected as the recipient of the Linnean Gold Medal, and addressed him in the following words :—

EDWIN STEPHEN GOODRICH: It gives me personally particular pleasure to hand you the Linnean Medal, as it recalls to my memory the days when, like you, I was a student of Zoology at University College under that inspiring teacher Sir Edwin Ray Lankester, himself a recipient of the Linnean Medal in 1925. You are a worthy successor of our great master. You followed him to Oxford as Aldrichian Demonstrator, and succeeded to his successor, Professor G. C. Bourne, in the Linacre Professorship of Zoology and Comparative Anatomy.

Your investigations into the excretory organs of the Invertebrates established the true nature of the nephridia and their distinctive difference from the 'coelomoducts'. These researches were not only in themselves of fundamental importance, but they have inspired both some of your pupils and workers in other countries to continue these investigations along further and fruitful lines.

Your morphological work on the structure of fishes culminated in the publication of the 'Treatise on Fishes' in Lankester's 'System of Zoology', a volume which will long continue to be appreciated by all students of Zoology. Your other morphological investigations into the vascular and coelomic systems, particularly in the group of Annelids, have led to most interesting and striking results.

These, and the other researches I have referred to, have been carried out with skill and perseverance during a busy teaching career, and in spite of many interruptions which the administration of a flourishing university department have necessarily entailed. Nor have these detailed investigations restricted your general outlook on Zoological Science, as your delightful volume on 'Living Organisms', with its many aspects of interest, clearly shows. Your more recently published 'Comparative Anatomy of Vertebrates', which will long remain a standard among advanced text-books, is a fitting memorial of a long and fruitful career as a teacher.

It is no wonder then that you were selected as editor-in-chief of the 'Quarterly Journal of Microscopical Science', that premier journal of comparative morphology in the English language, and the twelve years which have elapsed since your appointment have shown how worthily you have carried on its great tradition.

With such a record of scientific activities we feel there could be no more worthy recipient of the Linnean Medal, and in awarding it to you as we do for the great services you have rendered to Zoological Science, we remember at the same time, with gratitude, the invaluable help you have given to this Society as its indefatigable Zoological Secretary for a period of eight years.

In reply, Professor GOODRICH expressed his profound appreciation of the honour that had been conferred upon him.

In the introductory passage to his Address, the PRESIDENT made the following statements:—

The Assistant Secretary has already read the list, alas! too long, of Fellows who have died since the last Anniversary Meeting. Obituary notices of these will be included in the 'Proceedings'. But I cannot refrain from a personal reference to two or three whose loss we shall feel particularly keenly.

By the untimely and unexpected death of Major Thomas Ford Chipp, Assistant Director of the Royal Gardens, Kew, British Botany has lost a valuable and promising worker whom it could ill spare, and the Linnean Society an active and esteemed Fellow, who last session was serving on its Council, where he had gained the esteem and affection of his fellow members.

Dr. George Claridge Druce, by contrast, was a Nestor among botanists, and his death removes from our midst one who will long be remembered as one of the most kindly and helpful of systematists, always ready in his courteous way to give information and enlightenment in difficult points of discrimination of species and their varieties. Through the

Botanical Exchange Club he was, no doubt, in touch with most of the collectors of British plants, and ever ready to assist them. He was elected a Fellow in 1879, so that he was one of the oldest Fellows of the Society.

Through the death of Lieut.-Col. Tull Walsh the Society has lost one of the most regular attenders at its meetings, and one for whom all who were brought in contact with him must have had the greatest admiration. Though handicapped of late in his activities by a painful infirmity, I have never known him to complain, nor found him other than cheerful; and in taking his part in the proceedings and in the life of the Linnean Club he has set us an example which it will be difficult to follow. We shall not easily forget so admirable and lovable a nature.

Of the three Foreign Members whom we have lost, only one, John Isaac Briquet, was known to me personally, and I little thought when he assisted me last year in Geneva in some difficult identifications that we should be mourning his loss this summer. Apart from his contributions to science, he will be remembered as the active and energetic *Rapporteur général* in connection with the section of Nomenclature of successive International Botanical Congresses. In this capacity he rendered yeoman service to botanists of all nationalities, and his kindly personality will be remembered by all who were brought into contact with him.

Though we have lost three eminent foreign botanists during the past session, I am glad to think that the Society has made good these serious losses by the election as Foreign Members of Prof. Klas Elias Fries, of Stockholm, Eduard Fischer, of Bern, and Ludwig Jost, of Heidelberg. In addition, we have elected M. Emile Topsent, the distinguished zoologist, of Strasbourg.

I ought, perhaps, to refer also to the addition to our slender list of Honorary Members of His Imperial Majesty the Emperor of Japan, one of the few rulers of an empire genuinely interested in its Natural History, and who maintains in Japan his private botanical garden and laboratory.

Our remembrance of a former distinguished Fellow of the Society, Robert Brown, who for a long period of years acted as Librarian, and subsequently became Vice-President and President of the Society, was revived by our celebration in November of his discovery of the nucleus in the vegetable cell, a discovery which opened up a new and important chapter in the history of the anatomy of both plants and animals. A full account of this very interesting commemoration has been published in the 'Proceedings' of the Society.

The Treasurer's statement will have revealed to you that the Society has passed through a somewhat difficult financial period. Not only had we to pay for considerable and expensive

electricity alterations, but, owing to the depreciation of the pound, we had a considerable increase of financial liabilities in connexion with the necessary continued purchase of foreign periodicals. This has greatly restricted the money available for the purchase of new and important books, and we have had to rely largely, as the Librarian has already stated, upon the generous donations of books from Fellows and other friends of the Society. I trust that we shall be able next year to make good some of the deficiencies which have necessarily arisen. I am pleased to be able to announce that our Treasurer, Mr. Francis Druce, has made a generous donation to the Society for the purchase of books next year. Let us hope that his good example may be followed by other Fellows.

A few years ago we received generous assistance towards the expenses of the library from the Carnegie Trustees, for which we were, and are, very grateful, but, unfortunately, they were unable to continue their financial aid during the past session. We undertook, in return for their generous grant, to become an 'Outlier Library' under their scheme, and to loan books to non-members of our Society through the National Central Library. It may be of interest to you to know that we have carried out this undertaking with considerable success from the point of view of the scheme, as there has been a continuous and growing demand for books from our library. The number borrowed during the last five years has been as follows :—

1927-28	.....	53	volumes
1928-29	.....	62	„
1929-30	.....	136	„
1930-31	.....	190	„
1931-32	.....	237	„

In return, as the Librarian has stated, some of our Fellows have been able to obtain books we did not possess through the National Central Library. To carry out the obligations of an Outlier Library it is essential that we should bind up, without too much delay, the periodicals of the past year, as only bound volumes can be lent. Unfortunately, owing to financial stringency, we have dropped behind this session, and a considerable sum will be required in the next financial year for the necessary binding.

We have, as you will have seen from the balance sheet, some funds in hand, though not quite as much as this time last year, but these funds will be swallowed up by the cost of our publications, and these we are anxious to keep up in a high state of efficiency, not only for the benefit of our Fellows, and particularly of those who cannot, by reason of distance,

attend our meetings, but also because they are essential to us as a medium of exchange with other societies whose publications we desire to possess.

It may be of interest to you to know that your Council has decided to publish a series of important papers resulting from the Cambridge Expedition, led by Dr. E. B. Worthington, to the East African lakes.

As many of you know, your Council had offered to it, for purchase, a portrait of our former Foreign Member, Prof. Julius Sachs, painted by his daughter, an artist in Munich. Unfortunately, the Council, though desirous of possessing this portrait of one of our most distinguished Foreign Members, had no funds available for the purpose. I was asked, therefore, to endeavour to obtain from individual Fellows, by kindly persuasion, the necessary sum. I am glad to be able to report that the confidence of the Council in the generosity of the Fellows was not misplaced, and, with certain outstanding promises, the sum required for the purchase is now in hand, and I hope that at the commencement of next session, when we celebrate the Centenary of Sachs's birth, we shall be able to instal his portrait in our Rooms.

The PRESIDENT then delivered his Address on 'A re-examination of the Stigmarian problem'. On its conclusion, Dr. D. H. SCOTT, F.R.S., moved 'That the President be thanked for his excellent Address, and that he be requested to allow it to be printed and circulated amongst the Fellows' (see pp. 155-166). The motion was seconded by Sir SIDNEY F. HARMER, K.B.E., F.R.S., and being put to the meeting was carried with acclamation.

The Scrutineers of the Ballot, who had retired at the appointed times with the voting lists for the election of the Council and of the Officers, having completed their scrutiny, reported to the President, and he declared the result as follows:—

COUNCIL FOR 1932-3. — Dr. W. T. Calman, F.R.S.; Dr. G. S. Carter; Dr. S. E. Chandler; Mr. Francis Druce; Dr. Philippa C. Esdaile; Professor J. Stanley Gardiner, F.R.S.; Professor T. G. Hill; Professor H. S. Holden; Professor W. Neilson Jones; Mr. N. B. Kinnear; Mr. G. W. E. Loder; Professor E. W. MacBride, F.R.S.; Professor J. R. Matthews; Mr. J. R. Norman; Mr. John Ramsbottom, O.B.E.; Lt.-Col. J. Stephenson, C.I.E., F.R.S.; Dr. H. Hamshaw Thomas, M.B.E.; Miss E. M. Wakefield; Professor F. E. Weiss, F.R.S.; Mr. A. J. Wilmott.

(The retiring Councillors were Dr. G. P. Bidder, Mr. I. H. Burkill, Mr. G. R. de Beer, Professor R. R. Gates, F.R.S., and Sir Sidney F. Harmer, K.B.E., F.R.S.)

OFFICERS FOR 1932-3. — *President*: Professor Frederick Ernest Weiss, F.R.S.; *Treasurer*: Mr. Francis Druce; *Botanical Secretary*: Mr. John Ramsbottom, O.B.E.; *Zoological Secretary*: Lt.-Col. John Stephenson, C.I.E., F.R.S.

The PRESIDENT announced that he had appointed the following as VICE-PRESIDENTS for 1932-3:—Mr. Francis Druce, Dr. Philippa C. Esdaile, Professor J. Stanley Gardiner, F.R.S., and Professor T. G. Hill.

The PRESIDENT then declared the Session of 1931-2 closed.

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PROCEEDINGS OF
THE LINNEAN SOCIETY OF LONDON

Session 1931-32

PART IV (pp. 73-150)

NOTICE

Non-Fellows may obtain the Proceedings for the current year, including each part for the Session as published, by prepayment of 10s. 6d. post-free.

After Capt. Dollman's reply to the various comments, the PRESIDENT expressed his great interest in Captain Dollman's communication and in the series of specimens exhibited. He referred to the importance of such detailed observations of seasonal changes in colour, and indicated that Captain Dollman's observations showed that colour varieties should not be established on single specimens, obtained at one season only.

An account of an expedition to the Island of Marajó at the mouth of the River Amazons. (Lecture.) By Mr. J. T. Cunningham.

MR. CUNNINGHAM gave a general account, illustrated by lantern-slides, of the expedition made by Mr. D. M. Reid, of the Biology Department, Harrow School, and himself to the Island of Marajó at the mouth of the River Amazons. The special object of the expedition was to carry out experiments on living specimens of *Lepidosiren paradoxa*, in order to decide whether the vascular filaments developed on the pelvic limbs of the male during the breeding season actually give off oxygen to the surrounding water when the latter contains a very small proportion of oxygen in solution. The results of the experiments proved that oxygen was given off, and the experiments and results are described in detail in a paper which has been communicated to the Royal Society.

Mr. Cunningham then proceeded with his narrative as follows:—

We left Liverpool on 18 November 1930, and arrived on 19 December at Fazenda Camburupý, the house of a cattle range in the Island of Marajó. At this time the dry season had not come to an end; the first rain of the wet season fell on 21 December, but for some days after this there were only occasional light showers. Every effort was made to obtain *Lepidosiren* in the neighbourhood, either in the branches of the small rivers (igarapés) or in burrows in which the fish might be hidden during the dry season in the dried-up swamps.

We therefore proceeded to Fazenda Dunas on the north coast of Marajó, a place where Dr. Emil Goeldi, founder and for some years Director of the Museum at Pará, had obtained three specimens of *Lepidosiren* in 1897 and 1898 (Proc. Zool. Soc. 1898). We arrived there by sailing-boat on 16 January. The house of Dunas stands near the north shore of Marajó on the east side of a small igarapé which opens into the sea some distance west of the house. We were able to carry out our experimental work in one of the enclosed compartments of the space below the house, which, as usual on Marajó, is built on pillars, in this case of wood. The region of the fazenda naturally divides itself into three

portions, of which the natural features are in strong contrast, namely, (1) the shore, consisting of a vast extent of white sand with a very gradual slope, (2) the igarapé, with several branches or tributaries, and bordered on each side with dense vegetation of trees and bush, (3) the swamp-pastures, covered with a varying depth of water which was continually increasing during the period of our stay.

We identified the Rego de Jacaré magro, which is mentioned by Goeldi as the igarapé near which his specimens of *Lepidosiren* were taken, and we made frequent ascents of this igarapé in dug-out canoes, and searched the neighbouring swampy ground for *Lepidosiren* and its burrows, but very few specimens were obtained within the boundaries of the fazenda. We offered to pay a considerable price for specimens, and ultimately received specimens about once a week from men who lived at a place called Bonito, about eighteen hours' journey west of Dunas. We were informed that they were obtained by finding the nest-burrows in the mud at the bottom of the swamp at a depth of two or three feet of water. In one case a reed about eight feet long was brought to show the length of the burrow which had been opened out. Both males and females were received from Bonito. At first the males had only short incipient filaments, but in March specimens with longer filaments were obtained up to a maximum of 22 mm. We also received nests with eggs alive and developing, but we had no time, and it was not our purpose, to study the development of the embryo.

The fauna both at Camburupý and at Dunas was extremely abundant and interesting, and we had excellent opportunities to make observations on habits and habitats. One of the most interesting and abundant forms among the fishes was the four-eyed fish *Anableps tetrophthalmus*, which swims with its protruding eyes half out of water, and in relation to this habit has each eye divided horizontally by a band of pigment across the cornea, and the pupil and lens also divided into an upper and lower half, one adapted to vision in air, the other to vision in water. We were surprised to find this fish swimming on the open shore between the breaking waves when the tide was rising, and at the smooth surface of the extensive shallow tidal pools when the tide was out.

A vote of thanks to Mr. Cunningham concluded the meeting.

4 FEBRUARY 1932

Professor F. E. WEISS, F.R.S., President,
in the Chair

The Proceedings of the General Meeting held on Thursday, 21 January 1932, having been circulated, were taken as read and confirmed.

A list of names of those who had made gifts to the Library since the previous meeting was read and laid on the table.

The following Fellows signed the Obligation in the Book of the Charter and Bye-Laws and were admitted :—Hugh Charles Sampson, John Scott Lennox Gilmour, and Edmund William Mason.

Certificates of recommendation of the following candidates for Fellowship were read :—For the first time, in favour of George Taylor, Robert Moyes Adam, Mary Ethelwyn Millner, Norman Woodhead, and Robert Wilfred Inder.

The PRESIDENT announced that a notification had been received that the 12th International Congress of Zoology will be held at Lisbon in the summer of 1935.

The PRESIDENT announced that there is a vacancy in the list of Associates by the death of Andrew Scott.

The PRESIDENT referred to a letter he had received from Professor C. E. CORRENS, F.M.L.S., with reference to the specimens of yellow-flowered privet exhibited at the General Meeting of the 22 October 1931.

**Further notes on the genera *Fumaria* and *Rupicapnos*.—II.
By Mr. H. W. Pugsley.**

MR. PUGSLEY spoke of the nature of his further notes on the genera *Fumaria* and *Rupicapnos* and traced the progress of the knowledge of these groups since the publication of Olof Hammar's monograph in 1854. Most of the forms now described were collected in the recent Moroccan expeditions of the French botanists, and particularly by Prof. René Maire, of Algiers. It has been found that, while *Fumaria* species abound in Morocco as far south as the Anti-Atlas, the genus *Rupicapnos* is confined to the north of the country, and does not reach the Middle or the Great Atlas.

Attention was drawn to the prevalent occurrence of *Fumariae* in natural habitats in North Africa and elsewhere in the Mediterranean region, and lantern-slides of a number of stations of this kind on the coast of Southern Dalmatia and the adjacent islands were exhibited. The salient features of the general phanerogamic vegetation of coastal Dalmatia were touched upon and contrasted with those prevailing around Sarajevo, in the interior of Bosnia.

The PRESIDENT expressed the thanks of the meeting to the author.

Exhibit of the algal epiphyte, *Phaeothamnion*.**By Miss M. Godward, B.Sc. (Visitor).**

LIVING specimens were exhibited of *Phaeothamnion* from a pond in Epping Forest, where they occurred as epiphytes on water-plants. Attention was drawn to the fact that the specimens resembled more closely the form described by Pascher as *Phaeothamnion polychrysis*.

Prof. F. E. FRITSCH pointed out that the discovery of *Phaeothamnion* as a not infrequent epiphyte in the ponds of the Epping Forest region was of interest, because it showed that one had only to examine a little-explored habitat to find that forms hitherto regarded as rare were commoner than had been supposed. The same result had been obtained in investigating the growths on the stones of river-beds, where not only a number of rare forms, but also a considerable number of new ones, even including new genera of algae, had come to light. *Phaeothamnion* was the only filamentous member of Chrysophyceae so far found in this country, although others were known on the Continent. Its true systematic position had long been in doubt, but Pascher had definitely established that it belonged to the class Chrysophyceae.

Dr. E. J. COLLINS asked upon what aquatic form the epiphytic *Phaeothamnion* was found growing and whether it grew upon this form exclusively or predominantly.

The fungus-stone, *Polyporus tuberaster*.**By Mr. J. Ramsbottom, O.B.E., Sec.L.S.**

ONE of the photographs shown by the President at our last meeting reminded me of a fungus which I thought, perhaps, sufficiently curious to bring to the notice of the Society.

Since the earliest times there are references to a stone which, on being watered, gives rise to a mushroom. There are hints of it in many writers, and it is said to be mentioned by Strabo in 50 B.C. It appears to have had some connection with the mysteries of the Lynx, and was regarded as the coagulated urine of wolves to be found on the summits of high mountains. This idea is to be found seriously argued in the writings of the Renaissance period.

The stone, as a matter of fact, is a mixture of rock, earth, and pebbles bound together or permeated by the mycelium of the fungus *Polyporus tuberaster*. Biologically the fungus mycelium acts as a sclerotium, but morphologically the structure differs from a sclerotium in that it is not composed wholly of fungus; in other words, it may be regarded as a sclerotium which is interspersed with foreign material. The

stone may be of different sizes and composition, occasionally weighing as much as fifty pounds. The fruit-body is esculent, and at one time was held in such merit that it appeared on the tables of popes, kings, and dukes. It has gradually become more scarce, and this Mattiolo ascribes to the disappearance of woodlands. Such a strange phenomenon naturally aroused interest, and the explanations were almost as wonderful as the facts.

The classical locality for the *Pietra fungiea* is around Naples. It was from this neighbourhood that it was described or mentioned by Barbarus in 1534, Mattioli 1563, Caesalpinus 1583, Porta 1591, Caspar Bauhin 1623, Ferrari 1646, J. Bauhin 1650, Imperato 1672, Boccone 1697, and probably others.

In 1649 Marcus Aurelius Severinus wrote a thesis, 'De lapide fungifero &c.', though this is known chiefly in Brueckmann's edition of 1728. He discusses at length the question whether the stone arises from wolf's urine or whether it is analogous to truffles.

In 1729 Micheli clearly showed the nature of the *pietra funghi*, and has an annotated figure of a section of it, indicating the fungus.

Before this time Samuel Pepys much desired a specimen, as is seen from the following extracts from his correspondence :—

'Had I known Mr. Jackson had been so generall a virtuoso as I find he is, and a lover and collector of such curiosities as I find mentioned in the inventory of things sent in boxes from Naples, I should have minded him of the *lapis fungifer*, or the stone which produces mushrooms, which is to be had at Naples and no where else as ever I could heare of. I am sure he can have been in no place but all learned and ingenious persons who have been made happy with his acquaintance will be very ambitious of his corispondence, which I doubt not but he hath settled with them, and particularly with those of Naples. And if you please by your first to him to desire him to send thither for some of the *lapis fungifer* or mushroom stones, to be sent by the first shipping for England, you will oblige me and, if they come, I know they will gratify both yours and Mr. Jackson's curiosity.

'Capt. Hatton. Sept. 28. 1700.'

'I am ashamed to think of the disappointment you will meet with about my cargo of Lazarolles *, which will prove to be but one single one that I putt-up at Naples, as the first

* Medlars. Compare also: 'I am so unacquainted with Lazarolles as not to know how to prize my disappointment about them, only to find Captain Hatton (who continues his respects to you) looks upon them as a curiosity, and upon the *lapis fungifer* too. S.P. Dec. 3. 1700.'

I had then seen ; but since they have been more familiarized to me, in France, etc., I will consider what may be done as to Captain Hatton's proposal of sending to Naples for young-trees of them ; as also for the *lapis fungifer*.

'John Jackson. $\frac{5}{16}$. 1700.'

'Your friends (and particularly my self) are, I bless God, in perfect health here, excepting onely my excellent friend Sir James Houblon (who yet is at this time better) and Mr. Hatton, from whom I am specially to note to you the content he owns his having had in his perusall of your collections for me : adding (to give it you in his own words) that had he known so much of your virtuosoship as he sayes he now does, he should have minded you of one thing which he is sorry to find unmentioned by you, viz., the *lapis fungifer* or stone that produces mushromes, which is to be had at Naples, and no where else that he knows of ; wishing that you would yet send to your correspondent there (for he depends upon your having provided yourself of one) for some of them, as what would be a welcome rarity to your self and friends here.

'S. Pepys. Oct. 8. 1700.'

John Hill in 1758 published 'An account of a stone in the possession of the Right Honourable the Earl of Stafford ; which on being watered produces excellent Mushrooms'. He states that the Italian naturalists describe a coarse and loose kind of stone which retains always the quality of affording mushrooms when watered, and that they have passed into writings of other nations as *Lapis fungifer* and the Mushroom-Stone. The stone he described was in the possession of Lady Stafford (in spite of the typical Hillian dedication to the Earl of Stafford). Hill says that when broken it had 'somewhat of the appearance of those coarse granites, which we call, from the place where they are found, Guernsey pebbles, and with which the streets of London are paved'. He performed the 'experiments by which stones are usually tried' and found that part of the mass was mineral, 'but as part of the mass burns away, that is plainly not of a stony nature ; and its smell while burning shews that it is not bituminous : we are therefore to look for it in the vegetable kingdom ; and from this part alone we shall find the mushrooms produced from the stone arise. . . . What the unassisted eye thus discovers, a microscope perfectly explains to us'. He compares the 'roots' of the mushroom to those of lignicolous species which occur year after year on the same trunk, and instances an example of the Beefsteak fungus on ash (an unusual host) and 'for many years an annual fungus of vast size, and of a very peculiar form, from the block of a smith's anvil in the Hay-market'.

He records it as occurring in the mountainous parts of Italy toward Piedmont; and also in Sicily and some other places. He names the fungus:—

‘*Boletus stipitatus radice perenni, pileo depresso scabro, poris subangulatis.*’

Hill thus confirms Micheli’s account, but he has his own figure—a different procedure from that which he adopted in his ‘Natural History of Plants’ (1751), where he copied all Micheli’s figures without acknowledgement.

In his ‘Museum Britannicum’ (1791) Rymsdyk has a footnote to his account of ‘The Sallad Earthen Vessel, and the Scythian Lamb’.

‘It is but lately I found out by accident that they have likewise at the British Museum, a *mushroom-stone*, a kind of *Fossil*, extremely curious, for laying it in the earth, and a little earth on the top, then wetting it with water, *mushrooms* will shoot up in a short time. As to the germination and fructification, this is chiefly caused by the salt, &c., which renders land fertile, as may be seen of all manner of fruits, &c. planted in those salt marshes which flourish exceedingly, for those salts working with contrary salts in the seeds, exalt the principles of motion and vegetation, or as the poet says,

“All things exist by elemental strife”—POPE.’

The suggestions that have held sway in most writings are either that the stone is a truffle-like fungus on which the *Polyporus* is parasitic or that the fungus in the stone is the ‘root’ of the *Polyporus*. This is the same problem that perplexed the older mycologists about the nature of the sclerotium.

Gasparinni in 1841 still thought the stone itself to be a separate fungus, and called it *Mycelithe fungifera*.

The ‘Tuckahoe’ of N. America (*Grifeola* (*Polyporus*) *Tuckahoe* Güssow) is probably the same fungus. That of S. America, *Pachyma Cocos*, is a *Poria*.

The PRESIDENT expressed to Mr. Ramsbottom the thanks of the meeting.

Conceptions of phylogeny in the genus *Oenothera*.

By Professor R. Ruggles Gates, F.R.S.

THE genus *Oenothera* has a longer genetic history than any other plant. De Vries began his work with *O. Lamarckiana* in the ‘eighties, and the publication of his great work, ‘The Mutation Theory’, was begun in 1901. In 1905, study of the chromosomes in the mutants, and a decade later the main mutations with aberrant chromosome numbers, including

trisomics, tetraploids, and triploids, had been worked out (Gates, 'Mutation Factor in Evolution', 1915). Important as these types of change are in the evolution of other genera, they do not survive in *Oenothera*, where all the wild species have fourteen chromosomes.

It is now known that many *Oenothera* species and hybrids breed true because of catenation (linkage) of their chromosomes in meiosis. Investigation of this subject has become increasingly active during the last decade. Following the work of de Vries on twin hybrids, it has been shown that many species produce two kinds of gametes. Renner called these complexes, and gave them names. Thus the phenotype *O. Lamarckiana* is a combination of the complexes *gaudens* and *velans*. By extensive series of species-crosses the relationships between their complexes is being worked out. A few species, such as *O. Hookeri*, are homozygous, and have seven free pairs of chromosomes in meiosis, but the great bulk of species show more or less complete catenation, and as a result produce only two kinds of gametes. Frequently one pollen complex and the other egg complex are non-viable, or both types may be viable in both sexes, as in *Lamarckiana*. That catenation can arise from crosses between homozygous *Oenotheras* with seven free pairs of chromosomes has recently been shown experimentally.

Another fact of importance, shown by extensive investigations on the inheritance of flower-size, is that small flowers are usually dominant to large in species-crosses. Based on these and other lines of evidence, including distribution, the following conceptions regarding the phylogeny of the genus are developed :—

(1) The subgenus *Onagra* probably arose in Central America from the large-flowered subgenus *Euoenothera*.

(2) The large-flowered *Onagra* forms began to move northwards following the retreat of the ice in North America.

(3) In doing so they gave rise, through series of dominant parallel mutations, to progressively smaller flowered species, and at the same time hybridization between different specific types gave rise to further new species which bred true because of the chromosome catenation during meiosis which occurred in the crosses.

(4) Another series of parallel mutations gave rise to the various species and varieties with cruciate petals.

(5) In this way have arisen the more northerly small-flowered species with a high degree of catenation of their fourteen chromosomes.

(6) In the meantime much specific differentiation has also taken place through the accumulation of gene mutations, whose separate inheritance is usually obscured because

they belong to a complex, i.e. occur in linked chromosomes. Such gene mutations are exemplified by *rubricalyx*, *brevistylis*, and *nanella*.

(7) Segmental interchange of chromosomes has played a minor rôle in the evolution of the genus, chiefly in the direction of reducing the amount of catenation, and so producing more or less completely homozygous forms. An example is *O. Lamarckiana* ($(\textcircled{12}) + 1$ pair) $\longrightarrow$ *rubrinervis* ($(\textcircled{6}) + 4$ pairs) $\longrightarrow$ *deserens* (7 pairs).

(8) The heterozygous species, composed of two complexes and with a high degree of hybrid vigour, have a great advantage in the struggle for existence, and so the catenation has tended to increase to a maximum in the phylogeny of the genus; while more homozygous forms arising from them through segmental interchange, having less vigour, tend to be extinguished in competition.

The PRESIDENT moved the thanks of the Society to Prof. Gates for his very interesting communication. He desired to ask Prof. Gates, however, whether any observations existed as to the cross-pollination of *Oenothera* in nature. Obviously Prof. Gates's conclusions depended on an active hybridization by natural means.

Dr. E. J. COLLINS expressed personal thanks to Prof. Gates for the résumé dealing with the principal problems concerned in the phylogeny of the *Oenotheras*. He recalled the close study which Bateson had given to Renner's theory, a theory which involved the assumption of the formation at meiosis of definite viable chromosome complexes. This theory Bateson considered a great step forward in the elucidation of the complicated and elusive problem of inheritance in this genus, and Prof. Gates by his well-known researches had contributed in no small measure to the cytological confirmation of these results.

As one of the possible factors in the problem of the evolution of species, Dr. Collins concurred in the general importance of polyploidy, duplicate, differential or other, but he would like to hear the views of cytologists on the question in regard to a genus where there was a constant number of chromosomes throughout the whole run of species contained in it. Considerable work could be undertaken, he thought, with advantage on the genus *Lilium*, whose chromosomes in size and form seemed to offer a fair opportunity to the cytologist who desired to work on a group where polyploidy apparently did not exist. Generally, so far as he could see, no clear conception of the origin of species from the incidence of polyploidy, to which all could subscribe, had yet crystallized out.

Dr. F. W. SANSOME questioned the value of the analysis of the phylogeny of *Oenothera* species, and suggested that the phylogeny of the Renner 'complexes' was more important.

Sir SIDNEY HARMER enquired whether Professor Gates intended his statement that the homozygous condition is restricted to a single species to apply to the entire genus *Oenothera* or merely to the group of forms which have been specially studied by cytologists. He suggested that if the greater vigour of hybrids, associated with linkage of the chromosomes, were important in evolution, it might be anticipated that a large proportion of existing species, not merely in the genus *Oenothera*, would have linked or catenated chromosomes.

In his reply, Professor GATES emphasized the point of view that the relative importance of different evolutionary factors varied from one group of plants or animals to another. For example, polyploidy, which is of widespread occurrence in the phylogeny of Angiosperms, was apparently of very little significance in animals; and hybridization, which is an important condition in the phylogeny of some plant genera, might be negligible or non-existent in some groups of animals.

He stated that natural crossing took place more frequently in the large-flowered species, which usually required insect visits for an abundant production of seeds, whereas the small-flowered species had usually a short style and were normally self-pollinated in the bud. Nevertheless, even these species would undergo crossing when grown together in an experimental garden. His conception was that the greater amount of crossing, especially between widely different forms, had taken place in the earlier phylogeny of the genus, when the species had larger flowers and were moving northwards, spreading out and coming into contact with each other.

While polyploidy is a widespread condition in Angiosperms, yet it was not surprising to find genera, such as *Lilium* and *Carex*, in which species with chromosome multiples apparently do not occur. As polyploidy is only one means of differentiation, there is no reason why it should not be suspended in certain genera. It has recently been shown, however, that *Lilium tigrinum* is a triploid species.

O. Hookeri is the only *Oenothera* species at present known to be homozygous with seven free pairs of chromosomes. Catenation of chromosomes had recently been discovered in a number of other genera, usually on a smaller scale, and *Oenothera* was, therefore, not unique in this respect. The genus had, however, specialized in chromosome linkage, and this condition had probably arisen early in the phylogeny of the genus, beginning with segmental interchange of certain chromosomes.

Regarding Dr. Sansome's remark, it was pointed out that the aim of the work was an analysis of the relationships between the different complexes, and so between the various phenotypes (species) involved.

A vote of thanks to Professor Gates concluded the meeting.

18 FEBRUARY 1932

Professor F. E. WEISS, F.R.S., President,
in the Chair

The Proceedings of the General Meeting held on Thursday, 4 February 1932, having been circulated, were taken as read and confirmed.

A list of names of those who had made gifts to the Library since the previous meeting was read and laid on the table.

The following Fellows signed the Obligation in the Book of the Charter and Bye-Laws and were admitted :—Jessie Leese and Percival Sydney Jewell.

Certificates of recommendation of the following candidates for Fellowship were read :—For the second time, in favour of George Taylor, Robert Moyes Adam, Mary Ethelwyn Millner, Norman Woodhead, and Robert Wilfred Inder.

Bequest of Smithiana from Dr. Francis Pierrepont Barnard.

By the President (Professor F. E. Weiss).

AN interesting bequest has been received from the late Dr. FRANCIS PIERREPONT BARNARD, the great-grandnephew of Sir James Edward Smith, F.R.S., one of the founders and the first President of this Society. The items forming this bequest have been forwarded to us by Mrs. Ella Pierrepont Barnard, to whom the Council has already sent a resolution conveying its thanks and appreciation.

The bequest comprises the following items :—

(1) Sir James Edward Smith's own seal,—an agate engraved with a knight's helmet and the initials 'J.E.S.'; (2) Seven portraits of Sir James Edward Smith, of which five are engravings, one an etching already in the Society's collections, and the seventh an original drawing in chalks by Mrs. A. L. Lane, the wife of William Lane, a well-known portrait-painter and draughtsman. This original portrait of Smith as a young man is a valuable addition to the portraits possessed by the Society; (3) A small beautifully made cabinet that belonged to Sir James Edward Smith, and which contains his collection

of impressions of seals. This collection (some specimens from which were exhibited on the table) amounts to 538 impressions, partly collected by Smith and partly added by Dr. Francis Barnard. It is of particular interest to this Society, because it is obvious that the bulk of those collected by Smith came from the wrappers of letters addressed to Linnaeus and other contemporary naturalists; so that, in a minor way, this bequest makes an addition to the Linnaean Collections.

It may be of interest to mention a few of the celebrated men whose seals are represented in this collection. There are impressions of three different seals used by Linnaeus; the same applies to Solander. The younger Linnaeus's seal is also present. In addition, the seals of Haller, Jacquin, the de Jussieus, Jan Burman, John Ellis, Sir Joseph Banks, Alexander Garden, Stephen Hales, A. B. Lambert, Pennant, Dr. Richardson, Lettsom, John Mitchell, C. A. Agardh, Swartz, Masson, John Hope, Chantrey the sculptor, Hogarth the painter, and J. J. Rousseau are represented.

Dr. Francis Pierrepont Barnard was a Fellow of the Society of Antiquaries, well known for his works on numismatics and heraldry, his chief work being entitled 'The Casting Counter and the Counting Board', published in 1916. He was also the author of a well-known handbook on Mediaeval England.

Dr. A. B. RENDLE expressed the hope that a list of the impressions of seals would be published in the 'Proceedings'. The President replied that such a list would be published, probably at a later date.

Exhibit of specimens of *Protosiphon* from Egypt. By Professor F. E. Fritsch.

PROFESSOR FRITSCH demonstrated living specimens of the rare siphonaceous alga *Protosiphon* which had been grown by moistening dried desert-silt received from Professor Oliver from Egypt. After drawing attention to the interest of the alga as a possible primitive member of the Siphonales connecting them with Chlorococcales, the speaker read an extract from a letter of Prof. Oliver describing the occurrence of the alga in Egypt. 'The material sent is just the upper crust of solidified desert-silt which is brought in great quantities on to the ground of the Faculty of Science by flood-water from heavy showers in the adjacent desert. Numerous organisms gradually make their appearance at the surface during the following weeks and, if slabs of mud are kept under shades so as to reduce evaporation, there are additional ones. Among this population are seedlings of higher plants, moss protonemata, and eventually moss plants, sundry algae

and fungi, including yeasts. The first plants to break the surface are *Protosiphon* and *Botrydium*, the former in tufts, the latter more usually in solitary specimens. These algae appear only where the mud is sheltered from the midday sun. Evidently the desert is snowed under with their resting spores. Knowing something of the desert I have a high respect for the drought-resisting qualities of these plants.' Prof. Fritsch drew attention to the small size of the specimens shown, which might, perhaps, be attributed to the unfavourable conditions for growth in a London laboratory.

The PRESIDENT, after conveying the thanks of the meeting to Professors Fritsch and Oliver, commented on the exhibit.

In reply, Professor FRITSCH stated that *Botrychium* usually occurred on damp mud left by receding water, and that, when the mud dried, the algae formed resting spores and vanished.

The BOTANICAL SECRETARY then read

A note on an abnormal form of root in the scarlet runner bean.

By Miss Jean Dickson (Visitor).

IN clearing ground in November 1931 roots of scarlet runner bean (*Phaseolus multiflorus*) were seen to have an unusual appearance. The plants were growing in soil which was extremely poor and rubbly except for the surface layer. They had been attacked by slugs soon after planting, but the surviving plants had shown abundant vegetative growth, with few flowers and fruit. The aerial parts were frosted and died back in late autumn. The main root had developed into a large swollen tuber, four to six inches long and two inches wide in the thickest portion, much like an Umbellifer root, but with texture similar to that of a *Dahlia* tuber. There were from six to eight well-developed lateral roots on the upper part of the tap-root, some showing a tendency to become swollen above; the lower part bore scattered under-developed laterals. There were remarkably few root-nodules, which were confined to the laterals nearest the surface of the soil. The epicotyledonary region bore numerous fine adventitious roots which also occasionally had nodules on their upper parts. At the base were two lateral buds which probably had arisen in the axils of the cotyledons. One specimen was almost spherical. Sections from the larger laterals and main root showed starch in the xylem parenchyma, which was more developed than in normal roots; there was also a small amount of starch in the cortex. Millon's reagent showed faint traces of protein in the external layer, being most marked just below the epidermis. No oil was found. The tuberized roots recall those described by Tincker, produced by submitting them to short periods of daylight.

Dr. M. A. H. TINCKER stated that *Phaseolus multiflorus*, like other species of the genus, is of Mexican origin; there it is an herbaceous perennial with tuberous roots. Grown under the long days of a northern European summer, the roots rarely thicken before the autumnal frosts, to which this plant is very susceptible. When grown under short periods of light of twelve hours' duration, the upward growth is checked, and the rate at which food-products accumulate in the roots is increased; such tuberous roots will produce new stems and leaves in the following spring if they are lifted and kept free from frost during the winter.

It appears unlikely that edaphic factors greatly modify the form of the roots, as these thickened roots have been produced in different soil composts (lower Silurian grits and Bagshot sand), and in 'sand cultures', to which the salts added were controlled. The starch was translocated to the roots both with and without a ready supply of potassium (sodium was substituted).

The process of accumulation is an expression of the difference between the rate of starch manufactured and the rate of utilization of the carbohydrates in growth, governed by the period of light.

The PRESIDENT having conveyed the thanks of the meeting to Miss Dickson and to the Botanical Secretary for reading the paper, made some additional comments.

Development of auricular 'glandular' patches in the Waterbucks. By Capt. Guy Dollman.

CAPTAIN GUY DOLLMAN exhibited some specimens of heads of Waterbucks to illustrate the development of subauricular patches in the genus *Kobus*. The following observations were made during the exhibition:—

We are familiar with the occurrence of curious, more or less circular, naked patches situated just below the insertion of the ear in two types of antelope, the Reedbucks and Oribis of the genera *Redunca* and *Ourebia* respectively. The former are members of the subfamily Reduncinae and the Oribis belong to a group of small antelopes known as the Neotraginae. In both these genera these naked patches are almost always developed, there being only a single case on record of their absence in *Ourebia*, and two cases in which they are not developed in the Reedbucks. The patches are not glandular, and their function appears to be quite unknown.

Formerly the various genera of the subfamily Reduncinae were divided into two groups, those species with bare subauricular patches forming the first group and containing only the Reedbucks (*Redunca*), and those without subauricular patches constituting the second group and containing the

genera *Pelea* (the Vaal Rhebok), *Kobus* (the Waterbucks), *Onotragus* (the Lechwes) and *Adenota* (the Kobs).

Recently my attention was drawn to two specimens of Waterbuck, brought back from East Central Africa by the Hon. Masauji Hachisuka, in which bare subauricular patches, of varying size, were developed. These patches do not appear to be so well defined as in the Oribis and Reedbucks, but that they are structurally the same seems probable. Messrs. Edward Gerrard & Son examined their extensive stock and found four specimens in which this character was developed, and two of them I have here this evening. A detailed search through the collection of the Natural History Museum failed to produce any further instances of this peculiarity, but Messrs. Rowland Ward have provided me with a whole mounted specimen in which a bare patch is developed on one side only.

In some of the specimens I have referred to the patches are very unequal in size and do not appear nearly so uniform as they do in the Oribis and Reedbucks. In the Oribis these patches are either circular or roughly triangular in shape, and never exceed about three-quarters of an inch in diameter. In the Reedbucks they are rather larger, but are usually circular and do not spread over the side of the neck as irregular areas of naked skin. In no other genus of Antelopes except *Ourebia*, *Redunca* and *Kobus* have any traces of bare subauricular patches been discovered.

Mr. M. A. C. HINTON said that, with the help of his son, he had made a microscopical examination of portions of the skin from the subauricular patches. The sections showed merely horny stratified epithelium such as one commonly saw in callosities or corns, and there was no trace of any special glandular structure. He was inclined to regard the bare patches as the result of mechanical abrasion; the habit of scratching just behind the ears with the sharp hoofs of the hind-feet might be the real cause of these curious features.

Mr. R. H. BURNE asked whether anything was known of the position assumed by the feet during sleep, and suggested that the bare areas behind the ears might be due to the friction and pressure of the hoofs in this or some other habitual attitude.

Mr. J. T. CUNNINGHAM suggested that the callosities or dermal cornifications might be due to friction with the horn of an opponent in fighting, not necessarily to blows on the skin with the point of the horn, but to pushing and rubbing with the side of the horn of the adversary.

**Scorpions collected by Mr. Bertram Thomas in Arabia.
By Dr. Susan Finnegan.**

SIX species were represented in Mr. Bertram Thomas's collection of Scorpions from Arabia. Of these, one was a new species, and is the type of a new genus, belonging to the family Buthidae. In this form the tarsal spur is reduced to a small, weak spine, and is sometimes present on the fourth pair of legs and always absent from the third pair. Although this spine is of phylogenetic interest, it is doubtful whether the separation of the Buthidae into two subfamilies on this character alone is justifiable. The first three segments of the tail-region are flattened, the second segment having pronounced wing-like lateral expansions. This genus is nearly related to *Plesiobuthus*, described by Mr. Pocock in 1900 from Baluchistan.

Dr. CALMAN pointed out that the discovery of a new genus in a group so well known as the Scorpions was a matter of some general interest. The differences separating it from existing genera might appear trivial, but some of them affected characters such as the tibial spur, which had persisted since the Silurian epoch. He also called attention to the zoogeographical interest of the collections brought by Mr. Bertram Thomas from the hitherto unexplored regions of South-Eastern Arabia.

The Diatomaceae (recent and fossil) of the district of the Tay Estuary. By Dr. David McCall. (Communicated by Prof. F. E. Fritsch.)

THE paper for publication is a systematic report on the Diatomaceae of the Tay district from Carnoustie westwards to Glencarse, and from the Sidlaw Hills to the north of Fifeshire—an area of about 250 sq. miles; the neritic and plankton forms of the Firth of Tay are also dealt with. Since the district includes sea-coast, sandy shore, sand-dunes, meadow lanes, and uplands, the diatom flora is both rich and varied. Marine, brackish, lowland freshwater, sub-alpine, and alpine species are all well represented. Over nine hundred forms (species and varieties) are recorded, and these include a number of new records for Britain, and a number of new species and varieties. The diatoms of the Sidlaw Hills and adjacent country are particularly interesting, as here are found such 'relicta' forms as *Navicula gibbula* Cleve and *N. Semen* Ehrenb.

Up to 1924 *N. gibbula* had not been found south of the Polar Circle, but in that year Hustedt recorded it from the

Sarek Moutains and from the south of Finland, where he considered it to be a glacial relic. *N. Semen*, usually found in the fossil state, has previously been found in the living state in the Harz, where it is considered to be a survival from the post-glacial epoch. Both these diatoms occur in the living state on the Sidlaw Hills and in the surrounding country. As the Tay district affords ample evidence of severe glaciation in the moulding of the hills and in the deposits of boulder clays, sands, and gravels, the occurrence of these 'relicta' forms is of interest.

Tow-nettings from the Firth of Tay contained forty-five true marine plankton forms and a considerable number of bottom-living and littoral species. No rich seasonal development of neritic species was observed, and this may be attributed to the ebb and flow of the tide in the narrow estuary and to the large volumes of fresh water brought down by the Rivers Tay and Earn.

The fossil diatoms were obtained from the 25-ft. terrace (raised beach) exposed at various places between Dundee and Glencarse on the north bank of the Tay. The raised beach contains two well-marked layers of clay: the upper layer yellowish, sandy, and containing practically no diatoms; the lower layer of blue clay, and containing over forty brackish and marine forms. From the species found it is evident that when the blue clay was deposited the water was more brackish than it is in adjacent localities to-day. *Surirella pyriformis* Kitt., a common and characteristic diatom of the Tay to-day, was not found in the blue clay.

Only twenty species were found in the auxospore stage, and of these the majority occurred only once in that condition. A few diatoms, however, appear to produce auxospores fairly frequently, e. g. *Cymbella ventricosa* Kütz.

A new section of the genus *Navicula* is created for *Navicula gibbula* and allied forms.

Short descriptive notes are given on the localities and collections.

Professor F. E. FRITSCH emphasized the importance of the work on diatoms carried out by Dr. McCall. This group was either studied by microscopists without any considerable interest in the general aspects of botanical science or was dealt with by algologists, who had not the time or experience to treat them thoroughly. The speaker congratulated Dr. McCall on the thoroughness with which he had carried out his investigations, and commented on the large number of living species found in the Tay Estuary. It was striking that during such a systematic and prolonged investigation so few forms had been found with auxospores. He enquired

whether Dr. McCall had any views as to the possible means of survival of diatoms from one period of abundance to another.

Mr. J. RAMSBOTTOM congratulated the lecturer both on having had the courage to tackle a group of organisms which were unpopular and on the results he had obtained. He remarked upon the great economic importance of the systematic study of diatoms and the fact that large and valuable collections were awaiting expert examination.

Mr. D. J. SCOURFIELD asked if Dr. McCall had found the brackish-water diatom *Cylindrotheca* in the Tay district.

Dr. W. T. CALMAN associated himself with the remarks of the Botanical Secretary.

The AUTHOR replied to Mr. Scourfield that he had not found *Cylindrotheca* in the Tay district.

3 MARCH 1932

Professor F. E. WEISS, F.R.S., President,
in the Chair

The Proceedings of the General Meeting held on Thursday, 18 February 1932, having been circulated, were taken as read and confirmed.

The PRESIDENT referred to the loss the Society has sustained by the death of Dr. G. CLARIDGE DRUCE; those present rising in their places.

The PRESIDENT made an appeal to members to help him to raise a fund for the purchase of a portrait of Prof. JULIUS SACHS, one of the most distinguished of our former Foreign Members, the centenary of whose birth falls in the present year. The portrait has been painted by Prof. Sachs's daughter, a Munich artist, and it is hoped that it may be hung in the rooms of the Society.

A list of names of those who had made gifts to the Library since the previous meeting was read and laid on the table.

The following Fellow signed the Obligation in the Book of the Charter and Bye-Laws and was admitted:—Guy Coburn Robson.

Certificates of recommendation of the following candidates for Fellowship were read:—For the first time, in favour of Benjamin Peary Pal, David McCall, and Robert John Flintoff.

The following candidates, whose names were read for the third time, were balloted for and elected Fellows:—Idris Giles Lewis, Cecil Clement Dowding, Edward Thomas Brown, William Borlase, Alec William James Haggis, George Taylor, B.Sc., Robert Moyes Adam, Mary Ethelwyn Millner, M.Sc., Norman Woodhead, M.Sc., and Robert Wilfred Inder, B.A.

Lantern-slides illustrating *Oxalis natans* in South Africa.

By Sir Arthur W. Hill, K.C.M.G., F.R.S.

THE photographs were taken by Miss M. A. Pocock at Volvox Vlei, Cape Flats, near Capetown. The *Oxalis* is growing on the surface of the water of the Vlei, and the photographs were taken in September 1931. The *Oxalis* was shown in flower—the flowers being white—and the plant, which is tuberous, sends out long shoots which bear tufts of leaves which float like little boats on the surface of the water. In the summer time the vleis become quite dry and the shoots of the *Oxalis* die off, only the tubers remaining below the surface of the ground.

The PRESIDENT, after conveying the thanks of the meeting to Miss Pocock and Sir Arthur Hill, made some comments, and Mr. W. C. Worsdell also spoke.

Relative growth of mandibles in Stag-Beetles (Lucanidae).

By Professor Julian S. Huxley.

LINEAR measurements of length of mandibles and body (or elytron) made by Brindley, myself, and Dudich, respectively, in the males of three species of Lucanidae have been analysed. It is shown that the simple heterogony formula $y = bx^k$, where y = mandible-length, x = 'total' length (mandible-length + body-length), and b and k are constants, provides the basis for an expression of mandible-growth. The values of k are, for *L. cervus* about 2.3, for *L. lunifer* about 1.55, for *Cyclommatus tarandus* 1.97.

The approximation of actual to expected figures is close for the smaller individuals of each species. In all cases the curves bend over in the higher part of their range, the actual mandible-size falling progressively more and more below expectation. This, it is suggested, may be accounted for by the limited amount of food-material in the pupa being exhausted before very large mandibles can be formed.

In the holometabolous insects, such as the Lucanidae, it is assumed that the heterogonic relation between mandible and rest of body is produced in one of two ways—either by the formation of a substance responsible for heterogonic

growth of the mandible-rudiment, continuously throughout larval growth at a heterogonic rate ; or by the sudden appearance of heterogonic growth in the rudiments of the imaginal mandibles at a definite point in the pupal stage. Experiments on larval nutrition are needed to decide this point.

As a result of these facts it is concluded that the 'forms' of male Lucanids distinguished by coleopterists are purely growth-forms and have no systematic significance.

A tendency to multi-modality is evident in the frequency-curve for the mandibles of male *Cyclommatus tarandus* ; this appears to be correlated with the greater range of body-size in this species and consequent presumed greater variability of moult-number, as compared with the other Lucanids studied.

D'Arcy Thompson and Przibram have advanced a theory that the bimodality of heterogonic organs is due to a variation in moult number during larval life. This, however, as it stands, will not fit the facts, for it does not explain why the organ alone shows the bimodal curve while the rest of the body shows a unimodal one. If, however, it be supposed (1) that the processes influencing the rapid growth of a bimodal organ (e. g. the forceps of the male earwig) are always initiated at a fixed time after a moult, and that this moult is late in the animal's larval life : (2) that the conversion into adult male-type forceps can only occur at the assumption of the imaginal state ; (3) that the assumption of the imaginal state can occur either at the next or the next-but-one moult after the growth-influencing processes have been initiated—then, if in some males there is one more moult than normal, such animals will show the 'high' type of forceps, while those with the smaller number of moults will show the 'low' type.

Lt.-Col. J. H. TULL WALSH having spoken, Mr. J. T. CUNNINGHAM asked if it was certain that the enlarged mandibles (in the male Stag-beetle) were not in some degree developed, either in substance or in form, before the beginning of the pupal stage, that is to say in the later larval stages, in the interior of the body, though not visible externally.

Dr. W. T. CALMAN expressed his appreciation of the work Professor Huxley and his pupils were doing in giving precise and numerical expression to phenomena of which systematists had hitherto been aware only in a very vague and general way. In particular he called attention to the importance of Professor Huxley's discovery that exaggerated growth in one member of a meristic series tended to spread to adjacent members, especially those lying posteriorly.

Dr. G. R. DE BEER supported Dr. Calman's remarks and said that he would like to go further, and to point out that, in addition to systematics, many other branches of biology were indebted to the novel view-point which had emerged from Professor Huxley's studies on heterogonic growth. Itself an important constituent of embryology, it derived additional significance and interest in connection with the demonstration of growth-gradients, and the possibility of comparing them with other gradient-effects, associated with the name of C. M. Child. Morphology itself could not afford to neglect heterogonic growth, since in those cases in which organisms possessed heterogonic organs and no fixed final adult size there was no fixed shape. With regard to palaeontology, heterogonic growth had contributed an acceptable interpretation of certain phenomena of so-called 'orthogenesis'. In conclusion, he asked Professor Huxley whether he had any notion of the physical basis of the constant differential growth ratios.

Prof. HUXLEY having replied, the thanks of the meeting were conveyed to him by the President.

Some new and rare British Crustacea.

By Mr. A. G. Lowndes.

BATHYNELLA CHAPPUISI (?) Delachaux. In June 1927 two specimens were obtained from the underground stone quarries at Corsham, Wilts, but they were not recognized as Syncarida at the time, and were placed on one side. They were recognized as Syncarida in October 1931, and Dr. Calman believes them to be *Bathynella chappuisi*, but they are not fully grown. So far I have failed to find any more specimens. No member of the Syncarida has so far been recorded from the British Isles.

Eurytemora thompsoni Willey. This Copepod was obtained from brackish-water pools at Lancing, Sussex, last June. Previously the only record was that of Prof. A. Willey, of McGill University, who found dead specimens in the gut of a fish caught in a weir at low water at Scotsman Bay, Nova Scotia. Dr. Smirnov, of Leningrad, has also obtained the species from the Sea of Okhotsk, but not recorded it.

Asellus cavaticus Schiødt. Several specimens, both male and female, were obtained during 1931 at Corsham when looking for *Bathynella*. The species is a blind Isopod which had only been recorded in the British Isles from wells at Ringwood, Hants, though the species is fairly common on the Continent.

Phyllognathopus vignieri Maupas. This is a small Harpacticid which was first recorded in the British Isles by Mr. Scourfield, who obtained it from Bromeliaceous plants in Kew Gardens. It is to be obtained from similar situations in

almost any botanic gardens, and also occurred on one occasion in some experimental filters in the laboratories at Rothamsted. Lately I have obtained large numbers by soaking ordinary pineapple stems, with the leaves attached, in water. The species has never been found under really natural conditions in this country.

The PRESIDENT expressed the thanks of the meeting to the author, and stated that the matter was open for discussion.

Dr. W. T. CALMAN commented on the extreme interest of Mr. Lowndes's discovery of *Bathynella*, which had not hitherto been found nearer than Switzerland. It belongs to a very isolated order of Crustacea, the Syncarida, first discovered as fossils and later found to have living representatives in the Australian region and in the caves of central Europe. Several important contributions relating to the group have appeared in the publications of this Society since Mr. G. M. Thomson's description of *Anaspides* was published in the 'Transactions' in 1894.

Mr. D. J. SCOURFIELD said he had actually found *Phyllognathopus* several years before recording it in 1903. He would like to call attention to a very remarkable feature possessed by this form, namely, a pulsating or vibrating organ in the neighbourhood of the shell-gland. At first it was thought that this might be similar to the well-known vibratile organs in rotifers and many worm types, but it was shown later that the pulsation was really due to the rapid movement of a minute special muscle attached to a membrane forming the base of a small cavity.

PROFESSOR J. McLEAN THOMPSON gave a summary of Dr. I. V. NEWMAN's paper 'Studies in the Australian Acacias.—I & II', which, after the thanks of the meeting had been given, was followed by a lecture by Professor J. McLEAN THOMPSON entitled 'The theory of the Leguminous strobilus'. Professor R. R. Gates and the President having commented on the interest of the lecture, a vote of thanks to the lecturer concluded the meeting.

Studies in the Australian Acacias.—I. and II.

By Dr. I. V. Newman.

THE genus *Acacia* is one of the most remarkable genera of the Leguminosae, itself one of the most remarkable families of Flowering Plants. The series of Studies here introduced aims at a complete revision of the genus as found in Australia, where almost all known features occur, and will be centred round the phylogeny of the genus.

The systematic relations of the Leguminosae, Mimoseae, and *Acacia* as given by de Candolle, Engler and Prantl

(Taubert) and Bentham are reviewed. Bentham's division of the genus on foliage as the first principle of division, and the adoption thereof by authors of local floras is criticized as leading to too static a presentation. Distributed in all large land masses except Europe, the genus is particularly characteristic of Australia, where there are 500 species endemic out of a total of 700 species in the world. Only one Australian species occurs naturally on any other continent (*A. farnesiana*). The description of phyllodineous Acacias from the Tertiary of the Northern Hemisphere is regarded as erroneous on account of the scanty evidence and the fact (amongst others) that they do not occur naturally outside Australia at the present time. The habit, both vegetative and reproductive, is very diverse, as is the habitat of the genus. Except in connection with the anatomy and morphology of the foliage, very little is known about the internal construction and processes of the genus.

As relationships of organs rather than forms of organs are features susceptible of more prolonged or of repeating changes, they are considered as more suitable for the major divisions of a phylogenetic classification. Such relationships find expression in the forms of inflorescence and flower-groups, which are therefore taken as the first two principles of division. The changes are between the flower-groups in the inflorescence, and between the flowers in the flower-groups. Because, whatever be the form of the flower-groups, they are the parts of the inflorescence, the form of the latter is taken as the primary principle of division. The leaf-form is the third principle. This proposed phylogenetic classification starts, therefore, from a primitive form having racemose inflorescences of spikes of flowers and with true leaves (*Racemoseae-spicateae-phyllae*). Modification of the inflorescence can proceed by condensation through a condition with clustered flower-groups (*Constateae*) to one with solitary flower-groups (*Singulares*). By diminution of the vegetative axis and foliage, this condition could proceed to a simulation of the *Racemoseae*, and the line of transition be carried out again. At any stage in the transition the flower-groups could change from long spikes by condensation through dense, oblong spikes (*Oblongae*) to globular heads (*Globulae*). By reduction of the heads to single flowers with diminution of the inflorescence axis, a condition simulating solitary spikes (*Singulares-Spicateae*) could be obtained, and the line of transition in the flower-group be able to be repeated. At any stage in these lines of transition a third could take place in the foliage, proceeding through loss of lamina (*Phyllodineae*) to loss of the entire leaf, with functioning of small branches (*Phyllocladineae*). This line cannot repeat itself. A little thought shows the scheme to

bristle with cross-lines of transition in great complexity. This complexity explains some of the difficulty in classifying some species of *Acacia*, and provides a possible cause of certain genetical anomalies, e.g. inter-sterility of two apparently closely related species of *Crepis* while they are both inter-fertile with an apparently more distant species. The third would lie near the join of the lines of transition of the other two. In the distribution of the genus, the recapitulatory evidence from the seedling leaves, the anatomy of the foliage, and the arrangement of the flowers in the flower-head there is some support for the suggested scheme of classification.

In Study II the ecology, habit, floral structure, and the reproductive processes up to the formation of the spores of *Acacia Baileyana* are considered. The species is closely related to *A. polybotrya* and *A. pruinosa*, and in cultivation is suspected of taking part in hybridization.

The species occurs in a restricted area near Cootamundra and Wagga Wagga in the south-east of New South Wales, Australia, and appears to be associated with the conjunction of three conditions of environment—Silurian rocks, 18"–23" rain/ann., 500–1,500 ft. altitude.

The foliage is very glaucous, the height of the tree is between 5–8 metres, and there are pubescent and glabrous types. There are variations in the number of pinnae, the direction of rotation of the 2/5 phyllotaxy, the number of flowers in a head, and (slightly) in the number of floral members (except the gynoecium). The incidence and mode of sterility is very variable. By means of a model, measurements on serial longitudinal sections and serial transverse sections it is concluded that the flower-head is a condensed spike, the spiral of phyllotaxy having been made discontinuous in the process of condensation, so that the flowers appear in horizontal groups of five. A theoretical explanation of this is given. The method of termination of the axis of the flower-group is indefinite. The species appears to be in a labile condition.

The members of the floral whorls are described as arising in a spiral manner. Striking differences produced by the same stain on material killed in different fluids are made very clear by the presence of a mucilaginous substance in the sepals and legume. The minute anther with its eight microsporangia, each producing one 16-grained pollinium, is borne introrsely on a long thin filament. The superior gynoecium is in the form of an infolded leaf, the epidermes of whose appressed margins can be clearly seen in thin sections. The midrib proceeds into the style; but not the marginal bundles. The ten or twelve ovules are borne equally along the margins of the legume, and are from semi- to fully anatropous. There

is a case of a small flower growing as a continuation of the axis of an older flower, suggesting that the legume is a lateral structure to a suppressed apex. The unitary nature of the legume is considered established, as against the binary nature postulated under the theory of Carpel Polymorphism, and its foliar nature is supported as against the Phylloclade Theory.

The occurrence of sterility in its various modes is discussed. It is possible that a few pollen-grains might be formed with aberrant chromosome conditions. A connection is demonstrated between the absence of a mucilaginous material in the young legume and the presence of sterility. The sterility in *Acacia Baileyana* shows no trend towards the substitution, or entire elimination, of reproductive parts.

The very early stages of the microsporangia and of the ovules were not seen clearly. The anther is regarded as having eight separate archesporia, each of which produces a plate of four mother cells. The tissues of the anther are very reduced. The endothecium is one layer only. There is a characteristic single-layered inner tapetum with 'exine' facing the spores. The megaspore mother cell develops as usual from a single hypodermal archesporium, and gives rise to three or four megaspores in an axial row. Of these, either the chalazal or, more frequently, the distal one functions. There is a definite parietal tissue capping the mother cell or megaspores, but no definite tapetum. The ovule is naked, the integuments being only just discernible near the bend of the funiculus, and arising late.

The formation of the spores from the mother cells is followed in some detail, particularly for the microspores. The mother cell nucleoli have different appearances with different classes of fixative. At diakinesis there is a strong suggestion of the presence of types of chromosome, both in length and configuration—three or four small and ten or nine long. Trabants are also suggested at this and some later stages. Otherwise the process of meiosis appears to be as usually described. Discussion is given of the implications of the Chiasmatype theory of meiosis where a heterotypic daughter cell fails to divide but functions as a megaspore. The germination of such a 'spore' should always manifest cytological phenomena, and sometimes produce genetical results different from those in the case of a normal spore.

The chromosome number of thirteen is unusual among the Leguminosae, and suggests a tetraploidy based on the commoner numbers, six and seven.

Professor GATES remarked that Dr. Newman had spent two years in his laboratory investigating an immense amount of material of the genus *Acacia* which he had brought with

him from Australia, and this paper represented a portion of the results. Dr. Newman had done an extremely good piece of work. He had shown great care and attention to detail in the development of methods of morphological and cytological investigation in the genus, and it was very important that Dr. Newman should have the opportunity of continuing in Australia his comparative studies of the genus which he had begun so well. It was a curious fact that since the papers of Engler and Guignard, over fifty years ago, the floral structure of the genus, with its curious pollinia and rudimentary integuments, had been practically untouched. Dr. Newman had outlined a new classification of the genus, the details of which were to be filled in and tested later. His scheme breaks up the Phyllodineae, and indicates that there has been a large amount of parallel evolution in the genus, not only in the development of phylloclades, but also in the reduction and condensation of the inflorescences.

The PRESIDENT remarked on the obvious care with which these studies were being carried out, and wished Dr. Newman success in the scheme of investigations which he had mapped out. He thanked Professor McLean Thompson for so kindly coming from Liverpool to give a summary of Dr. Newman's studies.

**The theory of the Leguminous strobilus. By Professor
John McLean Thompson.**

ACCORDING to this theory, at some early stage in descent a Leguminous flower was strobiloid. Its organs were displayed in spiral succession, and were more numerous and more widely spaced than in any of the modern species. The basal organs were leaf-like and comparatively numerous. For the greater part they were sterile, though grading upwards into microsporophylls. Whatever were the forms of the latter, their modern equivalents are stamens. The flower was apetalous in the sense accepted for modern species. The microsporophylls and megasporophylls were leisurely produced; the latter were terminal, and the transition from vegetative to reproductive organs was gradual. In time the strobilus was shortened and the floral part-number was restrained. The transition from vegetative to reproductive organs was accordingly more clearly defined and localized as the influences directing the nature of the floral organs were expressed in more limited zones of the condensed receptacle. The equivalent of the modern corolla gradually arose in many species from such primordia in the zone of transition as were not fully committed to the vegetative group, and were affected in part by reproductive influences. Their early ontogenetic bias was towards vegetative development; their later developmental

history was controlled by closely contending vegetative and reproductive forces. The number and nature of the petals thus produced were at first varied. When the limits of vegetative and reproductive control in the receptacle had become more clearly prescribed, the number and nature of the petals were more strictly determined. Meristic variation, though of narrowed limits, persisted. As in some modern species, petals need not have arisen when the limits of vegetative and reproductive control were more clearly marked. Throughout, the part number of the lower vegetative organs was reduced by both inhibition of their primordia and limitation of the zones of the receptacle in which vegetative and reproductive influences respectively predominated. The modern bract, bracteoles, and calyx gradually emerged as residual organs of the vegetative group. The production of microsporophylls was now greatly reduced; the forms of the microsporophylls were in time more or less stereotyped, and their stamen nature was fixed upon them. The spiral succession on an elongated receptacle was early of variable order of divergence, but as the spiral succession was condensed the 2/5 succession tended to prevail as in modern species. Local crowding of floral organs was inevitable, and local suppression or displacement became general expressions of the crowded succession. The original gynoeceium was terminal, its axis was receptacular and elongated as a stalk or gynophore, and it showed branching. It shared with the receptacle as a whole the power of secondary growth, as in many modern species. Its branches were produced in spiral succession and bore naked ovules. As curtailment of the floral receptacle advanced the ontogenetic inception of the gynoeceium was hastened, its branch primordia became limited in number, the gynophore was generally shortened, and arrest or suppression of certain of the crowded gynoeceial branches was inevitable. Whatever had been the determining factors in reduction of the strobilus as a whole, the surviving gynoeceial branches had become organs of limited growth. The stigmatic surface arose as growth of the gynoeceial branches was restrained. The surviving gynoeceial branches gradually assumed their modern form of ovuliferous phylloclades of essentially uniform type, with secondary growth maintained as in many modern species. As their infolding, by inequality of growth rate, was accomplished, the modern ovary and placentae were more strictly defined. The legume character was completely expressed as the more apical portions of these megasporophylls were sterilized and the styles were provided.

In the vast majority of species the gynoeceium was gradually reduced to a single legume, still stalked or now sessile. The gynoeceium was now produced in close relationship of both

time and space with the restricted androecium, and stricter control of floral part-numbers of every category was displayed. Such control is manifest in modern species which show widespread suppression and omission of floral parts arranged in $2/5$ spiral succession. As the modern species arose, arrest, partial or complete, of either the gynoecium or the androecium was ever imminent, and separation of the sexes occurred. Perigyny is a modern development of the reduced strobilus, its incidence is virtually limited to species with low floral part-number, and its dominance and effects are best shown in the modern Bauhinieae and Papilionaceae.

On this theory the flowering of the Leguminosae is brought into line with older views on the Ranales. It is based on ontogenetic evidence from a comprehensive series of modern species in which arrest or suppression of floral parts, displayed in spiral succession, has been demonstrated, with change of interval between successive floral organs at whatever point in ontogeny a biological advantage may be assured by displacement of a primordium. It is shown that when, as in the Acacias, the floral part-number is high, the successive changes of interval are small, and are the minimal changes offering liberty to the floral organs already formed and in process of formation; when the floral part-number is low, the marked changes of interval entailed are likewise minimal, offering full liberty for the floral organs as a whole. Herein are two views of the Leguminous flower which are not mutually exclusive. On the first, the number of floral organs is inherent in the young receptacle before primordia have been defined. The positions on a spiral course at which the development of the potential number of primordia may occur is already defined for any one species, and withdrawal or advancement of primordia at a definable number of points is early determined. On the second view, change of interval between succeeding floral organs did not occur in the extended receptacle of the ancestral strobiloid flowers. As the strobilus was reduced, the phyletic spiral succession was, in general, maintained, but with withdrawal or advancement of primordia which would lie in too close radial association with established floral organs. To the inherent or phyletic tendency of ontogeny increasing nutritive or spacial difficulty had been opposed, and as the potential floral part-number fell, the latitude of primordial displacement increased, until, on a $2/5$ spiral succession, the maximum advancement or withdrawal of primordia involved a change of angle of 36° . The choice between advancement and withdrawal lay in the relative ease with which nutrition could be maintained in new alternative positions.

On the theory as a whole some aspects of meristic variation may be readily understood. Thus the passage from hexamery,

through pentamery and tetramery to trimery, would depend rather on the dominance of influences, vegetative and reproductive, on the spirally ascending primordia in Leguminous flowers than on any obligate production of floral parts of varied category in uniform number. Thus in the ancestral forms the transition from vegetative to reproductive floral organs was gradual, and the number of floral parts now classed as bracts, bracteoles, and sepals was relatively high. As the strobilus was curtailed, and the categories of floral parts were more clearly defined, meristic variation became more clearly evident. As the reduction of floral part-numbers progressed, the transition from vegetative to reproductive influence tended to be abrupt. The meristic variation of the basal vegetative organs of the flower was reduced to narrow limits, and is now so restrained as to merit recognition as exceptional rather than as the rule. On this view the petal is no longer an organ *sui generis*, or a transformed or degraded stamen or promoted sepal, but rather an organ of transition from calyx to androecium, liable to replacement during the ontogeny of the flower by either a sepal or a stamen, according to its position on the spiral course. The condition postulated is fulfilled in the Leguminosae, and apetalous species such as *Saraca indica* and *Dialium guianense* may be taken in point of reference. Both tetramery and trimery in the Leguminosae need no longer be expressed as resultants of immediately succeeding sectorial growth units, so arranged on the floral receptacle as to share, to the exclusion of other primordia, the available receptacular surface. Thus the generalization of Hofmeister, recently revived by Priestley, becomes unnecessary and, indeed, inapplicable. For both tetramery and trimery in the Leguminosae result from both fusion and arrest of floral part primordia arranged in 2 5 spiral succession, and from meristic variation as above considered, by which pentamery also may be, and is, provided. It is not necessarily imagined on the theory that the now dominant 2 5 succession in floral-part initiation has always been provided in the Leguminosae, but rather that from more complex and variable arrangements the spacial relationships of such a succession are now dominantly determined.

In the absence of numerous close gradations from the supposed elongated strobiloid Leguminous flower to such types as now show marked perigyny, it is suggested that curtailment of the strobilus has for long been pursued, is shown in its minimal condition by the Acacias and in its most extreme forms with perigyny in the modern Piptadenias.

The PRESIDENT thanked the lecturer for the clear exposition of his interesting views on the origin of the Leguminous flower.

17 MARCH 1932

Professor F. E. WEISS, F.R.S., President,
in the Chair

The Proceedings of the General Meeting held on Thursday, 3 March 1932, having been circulated, were taken as read and confirmed.

The PRESIDENT announced that the Council had awarded to Professor EDWIN STEPHEN GOODRICH, F.R.S., the Linnean Gold Medal, to be presented at the Anniversary Meeting on the 24th May next.

A list of names of those who had made gifts to the Library since the previous meeting was read and laid on the table.

The following Fellows signed the Obligation in the Book of the Charter and Bye-Laws and were admitted :—Robert Benson Ewhank, C.I.E., Mary Ethelwyn Millner, John Noel Milsum, and George Taylor.

Certificates of recommendation of the following candidates for Fellowship were read :—For the second time, in favour of Benjamin Peary Pal, David McCall, and Robert John Flintoff ; for the first time, in favour of the Right Hon. The Earl of Cranbrook.

Certificates of recommendation of the following candidates for Foreign Membership were read for the first time :—Professor Klas Robert Elias Fries, Professor Eduard Fischer, Professor Ludwig Jost, and Professor Emile Topsent.

Exhibit of a remarkable larval Cephalopod.
By Mr. G. C. Robson.

MR. G. C. ROBSON exhibited lantern-slides illustrating the 'Rhynchoteuthion' stage in the development of the Ommastrephidae (Decapod Cephalopoda). At this stage the young squid has the tentacles fused together to form a tubular structure (*Rüssel* of German authors), in which condition they continue until the squid is 8-10 mm. in length. The tentacles then come apart and assume the normal form and position. Mr. Robson's observations were based on an extensive series of specimens obtained by Dr. W. Beebe in the E. Pacific.

The PRESIDENT inquired if anything was known as to the food of these juvenile forms, as the tubular structure might be possibly an adaptation to some special mode of feeding.

Mr. J. T. CUNNINGHAM asked whether the tube described by Mr. Robson was ciliated internally.

Sir SIDNEY HARMER asked Mr. Robson to explain in greater detail the relations of the tentacles to other parts, and to give further information with regard to their tubular character when united.

Mr. R. H. BURNE asked whether the fusion between the tentacles was confined to the epithelium, and drew attention, if such were the case, to the parallel presented by the temporary epithelial fusions that occur in mammalian embryos, in particular the fusion of the lips in young marsupials.

Dr. W. T. CALMAN remarked that on the analogy of similar cases among Crustacea he would have been inclined to suspect that two or more species had been wrongly combined in one developmental series. As he was assured, however, by Mr. Robson that there was no possibility of this, the very remarkable course of development that had been described must be accepted as proved. As far as he was aware it had no close parallel elsewhere in the animal kingdom.

Mr. ROBSON replied.

Mr. J. T. CUNNINGHAM gave his account of a paper entitled 'The dehiscence of the sporocarp and germination of the spores in *Marsilia polycarpa* Hook. & Grev.', by himself and Mr. D. M. REID. After comments by the President (who conveyed the thanks of the meeting) and Dr. D. H. Scott, Mr. Cunningham replied.

Some Dune-slack Liverworts, including fertile specimens of *Petalophyllum Ralfsii* Gottsche. By Professor E. J. Salisbury.

PROFESSOR SALISBURY exhibited living fertile specimens of three characteristic liverworts of 'dune-slacks' growing together, viz. *Petalophyllum Ralfsii*, *Moerckia Flotowiana*, and *Aneura pinguis* v. *crassa*. He described how the two former persisted during the summer, partly through being covered with blown sand, but mainly by means of the thickened midribs. In *P. Ralfsii* the midrib developed terminally into a tuber containing fungal hyphae, and the lamina was renewed when conditions again became moist.

After the thanks of the meeting had been conveyed to Professor Salisbury, the PRESIDENT also showed specimens from Cumberland and Mr. J. RAMSBOTTOM spoke.

Problems of desert vegetation.

By Mr. Eric Ashby.

THE problem which faces all life in the desert, whether of man or animals or plants, is the problem of water economy. Yet it is significant that there are very few areas on the earth from which life is excluded through lack of water. The barrenness of parts of the Sahara is due to the shifting nature of the sand ; that of the desert of Utah is due to the high concentration of salts ; and the barrenness of the mountain tops is due to cold.

The following account embodies sundry observations upon the environment and vegetation of the Sonoran Desert. This desert is bordered on the north by the Colorado Plateau, and in the south it merges into the thorn forests of Mexico. The region offers a great deal of interest to the ecologist, for the problem of water economy has been overcome in a variety of ways, and the desert is peculiarly rich in vegetation, on account of the biennial seasons of rainfall.

The temperature of the desert ranges from freezing-point and lower, during the winter nights, to 110° and higher, in the shade in the summer ; but a frost never lasts more than twelve hours, and on an average two hundred and forty days in the year are free from frost.

The greatest annual rainfall ranges around ten inches, though it has been as low as five inches. It falls into two well-defined seasons—Summer (July–September) and Winter (December–February). Most of the rain falls in July, in storms of tropical intensity. Indeed, on one occasion five inches fell in one day, and it is not infrequent for half the annual rainfall to come within two weeks.

A corollary of these bursts of rainfall is the occurrence of long periods of drought, and it is only those plants which can endure such periods which remain the regular denizens of the desert.

Plants in the Sonoran Desert tide over these periods of drought in one of three ways. Very many of them die as the water shortage becomes acute, and are perpetuated by means of seeds. Such plants are somewhat misleadingly called ‘annuals’. During the dry periods they remain in the soil as seeds. A few days after the first appreciable rain the ground becomes carpeted with seedlings, and the colour of the desert turns suddenly from brown to green. During the rainy period these plants grow with surprising rapidity. In a few weeks they are in flower and fruit ; and by the time the dry season begins again the seeds are dispersed and the short-lived population has withered away.

There are two such crops of ‘annuals’ in the year, corresponding to the summer and winter periods of rainfall.

A comparison of these species at these two periods reveals one very striking fact: that the summer 'annuals' are a completely different flora from the winter 'annuals', *not one species being common to the two periods*.

It is believed that this complete contrast between the summer and winter floras is due to the selective action of temperature upon germination. Temperatures during the summer rainy period are consistently high; during the winter rainy period the night temperatures are sometimes below freezing-point. If this is indeed the explanation—and there is experimental evidence to support it,—it is a most striking instance of the importance of temperature for the germination of species.

The most characteristic plants in the Sonoran Desert are the succulents, and these tide over the dry period in a totally different way. In fact, it may be said that *internally* they never suffer shortage of water. Their root system is shallow, and drains a relatively large area of the surrounding soil. After a rain it is easy to measure the increase in girth of the fleshy stems. In the ensuing dry period the water loss from the succulents is reduced to a minimum. During the hotter days the stomata are closed, so that the water supply is preserved in what is virtually a waterproof bag. It is estimated that a giant cactus such as *Pachycereus* may store as much as eight tons of water.

The third group of desert plants do not store water against the dry season, nor do they die and leave only seeds behind them. They are deciduous; immediately the soil becomes dry they lose their leaves, and the bare branches which remain are able to endure wilting for long periods without harm. These plants are among the most successful desert plants, and they present the deepest problem to the ecologist, for they transpire water very rapidly (relatively more so than mesophytes*), and they have no *apparent* method of surviving the dry season. Their adaptation undoubtedly lies in the property of the protoplasm to withstand desiccation, and it is to the interpretation of this type of physiological adaptation that the ecologist will have to turn for a solution of the problems of desert vegetation.

The thanks of the meeting having been expressed by the PRESIDENT, the following added comments, and the lecturer replied,—Professor E. J. Salisbury, Mr. R. Paulson, Professor J. R. Matthews, Mr. A. D. Cotton, Dr. T. A. Sprague, and Mr. J. Ramsbottom.

* I have given some data upon the transpiration of these desert plants in 'Ecology', xiii, 1932, pp. 182-8.

14 APRIL 1932

Professor F. E. WEISS, F.R.S., President,
in the Chair

The Proceedings of the General Meeting held on Thursday, 17 March 1932, having been circulated, were taken as read and confirmed.

A list of names of those who had made gifts to the Library since the previous meeting was read and laid on the table.

The following Fellow signed the Obligation in the Book of the Charter and Bye-Laws and was admitted :— Clifford Gerald Hansford.

The PRESIDENT announced that the following notice had been received from the Secretary of the Sixth International Botanical Congress :—

‘ According to a decision by the Fifth International Botanical Congress at Cambridge in 1930, the Sixth Congress will be held in Holland in 1935. An Executive Committee has been formed, the President of which is Professor Dr. F. A. F. C. Went (Utrecht), while Professor Dr. J. C. Schoute (Groningen) will act as Vice-President, Dr. W. C. de Leeuw (Bilthoven) as Treasurer, and Dr. M. J. Sirks (Wageningen) as Secretary. The Committee has decided that the Sixth Congress will meet at Amsterdam, 9–14 September 1935. Scientific societies are kindly requested to reckon with these dates in planning their own meetings.’

In accordance with Chap. X, Sect. VII of the Bye-Laws, the following Fellows were elected, by show of hands, as Auditors of the Treasurer’s Accounts for 1931–32 :—

Representing the Council : Mr. I. H. Burkill.

Dr. Philippa C. Esdaile.

Representing the Fellows : Mr. R. H. Burne.

Mr. H. W. Pugsley.

Certificates of recommendation of the following candidates for Fellowship were read :—For the second time, in favour of The Right Hon. The Earl of Cranbrook ; for the first time, in favour of George Francis Scott Elliot and Martin Audley Foquett Sutton.

Certificates of recommendation of the following candidates for Foreign Membership were read for the second time :— Professor Klas Robert Elias Fries, Professor Eduard Fischer, Professor Ludwig Jost, and Professor Emile Topsent.

**Some unusual female catkins of *Corylus*. By Professor
F. E. Weiss, F.R.S., Pres.L.S.**

As is well known, the female catkins of *Corylus* arise as lateral structures in the axils of foliage leaves. In the autumn they are indistinguishable from vegetative buds, and it is only in spring, when the red stigmatic filaments project, that they can be recognized as reproductive organs. They are evidently much reduced inflorescences producing only six to eight pairs of ovaries, each surrounded by a small involucre formed by the fusion of a bracteole and two secondary bracteoles. Each pair of ovaries is subtended by a small oval bract.

TEXT-FIG. 1.



Young vigorous shoot of *Corylus* bearing male catkins in the axil of the lowermost of the three leaves and a female catkin in terminal position at the end of the shoot.

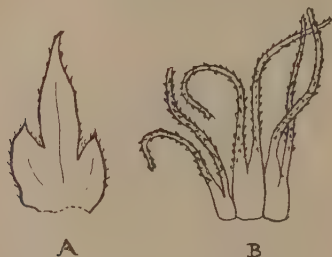
When hazel bushes have been cut back in hedging they produce numerous vigorous unbranched shoots which, after bearing a number of foliage leaves, taper off into tips clothed with small bracts. In the lanes of Westmorland and Cumberland I have sometimes found that these sappy shoots end in the autumn in the production of female catkins which occupy a terminal position. Such catkins are easily recognizable, consisting as they do of twenty to thirty bracts, between which the stigmatic filaments project (see text-fig. 1). These

filaments are not red as in the normal inflorescences, but are green, and have obviously no chance of being pollinated, as the normal male catkins are still immature.

On dissecting these autumnal female catkins it will be seen that their ovaries are borne in groups of three (see text-fig. 2, B) so that the median flower which is present in *Betula* is developed in these abnormal female catkins, while it is absent from the normal inflorescences of *Corylus* and also from those of *Carpinus*, which is closely related to *Corylus*. Occasionally this median flower may be found in normal female catkins of the hazel.

Another character which these catkins of *Corylus* share with those of *Betula* is the fact that the bract subtending each group of three flowers is tripartite, consisting, apparently, of a bract and two bracteoles fused together (see text-fig. 2, A),

TEXT-FIG. 2.



Dissection of abnormal female catkin of *Corylus*.

- A. Subtending bract to which the two bracteoles are fused.
B. The three female flowers, one median and two lateral, found in the axil of A.

while in the normal catkin of *Corylus* the subtending bracts are simple and oval, the bracteoles taking part in the formation of the involucre together with the secondary bracteoles. Of these latter there was no trace in the abnormal autumnal catkins.

These unusual catkins are of interest, as they probably represent an ancestral condition of the female inflorescence before it had become reduced to the bud-like structure which at present represents the female catkins of *Corylus*. In the more primitive condition the terminal catkins consist of a larger number of flowers in groups of three, subtended by a bract to which two bracteoles are fused. In all these particulars they resemble very closely the female catkins of *Betula*, and emphasize the relationship of *Corylus* and *Betula* already expressed by systematists in placing *Corylus* in a subfamily of the Betulaceae.

Mr. I. H. BURKILL commented upon the peculiarly interesting association of two abnormalities following upon the pruning, the first the outgrowing of the terminal bud, normally arrested in nature, and the second the development of the median florets in its catkin.

Dr. T. A. SPRAGUE considered that the mutilation (cutting-back) of the hazel bushes concerned supplied the stimulus occasioning the reversionary phenomena described by the President. Where reduction had occurred in the course of evolution, cutting-back frequently caused reversion, owing to the increased amount of sap available for the reduced number of growing points. Thus, mutilation in the common Ash, *Fraxinus excelsior*, frequently resulted in the production of shoots bearing leaves in whorls of three each, a condition regarded by Dr. Sprague as primitive for the Oleaceae; and he had observed in the Murree Hills, Punjab Himalaya, shoots of a coppiced *Pyrus Pashia* bearing *pinnatifid* leaves in the place of the usually *undivided* ones.

The PRESIDENT having replied, the Vice-President in the Chair (Mr. FRANCIS DRUCE) conveyed to him the thanks of the meeting.

Exhibit of specimens of mosses acting as 'Tumble-weeds'.

By Mr. H. N. Dixon.

FRAGMENTS of moss detached from the soil having become lodged in hollows from which they could not escape, while subject to slight movement by the wind, had continued producing branches in all directions, according to the temporary position of the tuft, until all differentiation of basal and terminal end had disappeared, and the plant sometimes had taken on a perfect spherical form, in others a subspherical, lenticular or bun-shaped form. In these conditions they were easily driven for considerable distances by the wind, thus aiding in the spread of the species. Only four kinds of moss have at present been known to act thus, three being British and one in New Zealand.

Mr. H. N. RIDLEY pointed out that in the Scotch mountains, where the fierce gusts of wind tore up the peat and transported bits to a considerable distance, moss-plants would undoubtedly be carried with them, and referred to the fact that the widely dispersed lichen *Usnea barbata*, known to Malays as the 'excreta of the wind', owed its distribution all over the world to the action of wind transporting whole plants, and many mosses at high elevations might be similarly borne.

The PRESIDENT expressed the thanks of the meeting to Mr. Dixon.

The Tree Senecios of the high African Mountains.

By Mr. A. D. Cotton.

The tree Senecios, which in growth-form belong to the branched 'rosette tree' type as defined by Warming, are confined to the six high mountain masses of East Tropical Africa mentioned below, all of which lie within 4° of the Equator. They possess a stout woody trunk, rosettes of large leaves, and very large terminal panicles of flowers. The branching is (usually) dichasial, two lateral buds developing after flowering and continuing the axis, so that the stem architecture is cymose. A characteristic feature is the mass of marcescent foliage, especially in the forms inhabiting the highest altitudes. All species are peculiar to the mountain mass on which they occur.

The species occur in zones, and their bulky and often grotesque forms are a most striking feature of the sub-alpine and alpine regions of the mountains. Their distribution is as follows, the species being given in order of decreasing altitude:—

RUWENZORI.

S. Friesiorum Mildbr.
S. adnivalis Stapf
S., sp. n.
S. longiligulatus de Wild.

MT. ELGON.

S., sp. n.
S. elgonensis Th. Fries
S., sp. n.

MT. KENYA.

S. keniodendron R. E. & Th. Fries
S. Battiscombei R. E. & Th. Fries
S. Brassica R. E. & Th. Fries

VIRUNGA RANGE.

S. alticola (Mildbr.) Th. Fries
S. Erici-Rosenii R. E. & Th. Fries

KILIMANJARO.

S. Cottonii Hutch. & Taylor
S. kilimanjari Mildbr.
S. Johnstonii Oliver

ABERDARE RANGE.

S. aberdaricus R. E. & Th. Fries
S. brassiciformis R. E. & Th. Fries

Those species occurring in the sub-alpine zone (9,000–11,500 ft.) have large heavy leaves, which are glabrous or protected by a moderate tomentum. The species of the alpine zone (11,500–14,000 ft.) ascend almost to the limit of vegetation where extreme contrasts in weather conditions obtain, rainy periods alternating with periods of drying winds, and hot sun by day alternating with severe night frosts. The leaves of these species, which, in spite of the conditions, are often exceedingly large, contain numerous mucilage (or oil) ducts, and are protected on the under-side by a very dense tomentum which may be short or shaggy.

The origin of the giant Senecios has been sought in one or more common ancestors formerly widely distributed, which, with the advent of warmer conditions, ascended higher up the mountains, and have since become specialized into distinct species. The discovery of some new species at the

junction of the forest-belt and the sub-alpine region which are intermediate in form between the typical 'giant' *Senecios* and the forest species, indicates that the upper forest-belt of the respective mountains cannot be ignored as a possible source of the alpine tree-forms.

Reference was made to the ecological features of the mountains and to the comparable growth-form exhibited by the genus *Espeletia* in similar latitudes on the Andes of Colombia.

The PRESIDENT expressed his thanks to Mr. Cotton for the very clear way in which he had given his account of the interesting series of *Senecios*. The distinct species existing on the separate mountains reminded him of endemic species characteristic of insular floras. He would like to ask whether the alpine forms were likely to have been derived from the less modified forms found in the forest region by adaptation to more rigorous conditions.

Dr. O. STAPF asked if any differences in floral structure could be detected between the flowers of the typical species of *Senecio* and those of the 'giant' species, and whether annual rings were present in the wood.

Mr. COTTON replied that no traces of annual rings were present in the species he had examined. The floral structure appears to be normal.

Biological principles in the control of destructive animals.

By Martin A. C. Hinton.

THE destructive mammal problem has forced itself upon human attention since the very earliest times. Its cruder or simpler forms, as presented to us, for instance, by the larger and fiercer *Carnivora* when they seek to devour our domestic animals or ourselves, or by certain ungulates when they enter our fields and gardens in order to steal or destroy our crops, have quickly found solutions in all parts of the world. Man learned everywhere to protect himself and his belongings behind barriers of all kinds, supplemented, when necessary, by the use of fire. The earliest textbook on the subject (which I have not seen) probably said:—'If you cannot cage your wild beasts, then encage yourselves.' That was the first step—or rather the second; for a long series of experiments, sometimes repeated even in our own day, had already conclusively demonstrated that flight was always tiring and often ineffectual. Then came the invention of weapons. This, too, had simple beginnings, for weapons of defence may be said to have been invented by the first woman who protected her babe from a wolf with a brand snatched from the fire, or by the first man who threw a stick, or a stone, or even the

baby, at that wolf to protect his dinner. Similarly, the first stout-hearted fellow who sharpened a stick or a stone and went out to slay the wolf may be hailed as the first and true inventor of weapons of attack. From such humble beginnings, by means of a long chain of weapons in wood, stone, copper, bronze, iron, and steel, we have arrived at the modern rifle and machine-gun. And from the corrosive sublimate and phosphorus of the Middle Ages we have got to poison gas and strychnine. By these many inventions man has completely turned the tables on his ancient foes, and from being the attacked he has become not only the attacker, but the exterminator. Species after species, in all lands and in all seas, have succumbed before the attacks made upon them by men seeking safety, riches, or sport, until at length the poor zoologist has to confess that the white man is, perhaps, the most dangerous mammalian pest in the world. But, thanks largely to the advancement of science, men seem about to realize at last that every species is worth keeping for itself, provided that we can control its numbers, distribution, and activities. Of course, every so-called noxious species will cost something to preserve; but whether we have to pay much or little for it depends entirely upon ourselves. That the price is worth paying cannot be doubted when we reflect that each species is really a page in the great book of evolution, with its own history and its own special message for the man who can read it. With its aid we may read other pages; but, without, many may become meaningless.

One of the most important characters of mammals, a character which they share with birds, and possibly with some few lower animals, is their educability. Lankester is usually cited as the first to draw such a distinction between the mammals and birds on the one hand and the lower animals on the other. But a knowledge of the fact that mammals are educable is a very ancient possession; and I am sure that Dr. Calman could furnish me with half a dozen quotations from Solomon or some other writer of respectable antiquity to prove that point. Because they are educable, wild mammals and birds learn to avoid man, and especially the man with a gun. They can also be taught to shun cultivated places if all that enter there are frightened, hurt, or even killed. Thus the scarecrow gains its efficiency in our fields, and thus the Game Warden in Uganda protects the shambas from elephants. It is along such lines rather than by methods of extermination that we should proceed against the larger destructive mammals.

Let us look at the case of the African Elephant a little closely. Even in Africa space is strictly limited, and the area suitable as dwelling places and feeding grounds for

elephants is steadily dwindling before the advance of civilization. Probably three or four young elephants can get a living on the food and space that would suffice for one old bull alone. So that old bulls form one of the great checks upon the undue increase in the numbers of elephants. But for many years ivory hunters have systematically and relentlessly pursued the great tuskers, i.e., the fully mature and old bulls; and in recent years the law in most parts of Africa has protected the calves—not that there was any commercial inducement to shoot them. We have thus destroyed an essential part of the natural mechanism by which the numbers of elephants are controlled. As a result complaints come from Uganda that the number of elephants has increased alarmingly, and that in many districts repressive steps have had to be taken against them. Were I a dictator, I should now order, both in the interests of the elephant and of the colony, a drastic thinning out of the calves and adolescent elephants and strict protection of all the sizable individuals. Every calf that entered a shamba would be killed, but every sizable animal would be scared away if possible. Naturally I should watch the progress of the experiment and its effects with the utmost attention, ready to denounce and stop it if an unforeseen disaster threatened. In all such matters one must be prepared for the unexpected; and that which will work in one part of a continent may fail in another.

It is not merely for aesthetic reasons that I would urge the preservation of such formidable animals as the larger cats and dogs. Although, perhaps, not to be tolerated in close proximity to human settlements, they should be given sanctuary in all those reservations for wild life which have been established in various parts of the world. This does not mean that they should be allowed to breed entirely without control in such places; but the numbers of the larger Carnivora are chiefly dependent, in natural conditions, on the numbers of the ungulates. They have to run for their dinners, and the value of the dinner depends upon the distance to be run. In these two facts lies the secret of the natural control of the carnivorous population.

In North America they have made great efforts in recent years to control or, rather, eliminate many of the larger predatory mammals. One of the species brought to the verge of extinction is the Mountain Lion (*Felis couguar* Kerr), which formerly had a wide range almost throughout the United States. To-day it seems to be represented by about a dozen individuals in the Yellowstone Park. It has been practically killed out in the Kaibab National Park, in the Grand Cañon district, with disastrous results. In that limited area the deer, deprived of their one natural enemy, bred to excessive

numbers, so that in 1924 there were 30,000 deer in the Park ; these were dying of starvation, the grass had gone and the foliage of many of the trees was eaten away as far up as the deer could reach. In the summer of 1929 Dr. Vorhies visited the Kaibab after fifteen years in Arizona. He says: 'The scenes of destruction that I saw there will remain with me to the rest of my life if I never go back again. I do not believe that by any process at present in sight we shall reduce that deer herd in the next twenty-five years to what it ought to be reduced to, to bring that forest back. We need the mountain lions.'

At the same meeting of the American Society of Mammalogists in May 1930, Mr. Goldman, who was defending the Government Predatory Animal Control measures, said: 'The fact is that there are not nearly as many deer now (in the Kaibab) as there were in 1924. The deer reached their peak there in that year. Since then they have been reduced. But they are reducing forage at a still faster rate, and of course we do not know just what the end will be. It seems to me that it will take a good many years probably before the situation is straightened out or that the vegetation can come back in any great quantity.'

Now the point I want to make on this Kaibab experience is this. The deer themselves have suffered material damage by the elimination of the Mountain Lion. Their numbers after that event rose to a peak far beyond the capacity of the country, so that they destroyed the forest ; starvation, coupled with inactivity and over breeding, owing to the unnatural peace of their surroundings, have sapped the strength of the deer ; weakened in these ways, and now declining in numbers, they may fall to the first epidemic or first bad year that comes along and be eliminated too.

One of the chief objects of the United States Predatory Animal Control is the elimination, in the supposed interests of the sheep-breeders, of the Coyote or Prairie Wolf (*Canis latrans* Say). This animal, with the clearing of the country for the purposes of agriculture, and with the elimination of other Carnivora, has greatly extended its range in recent years. For instance, in the West, where its northward limit used to be in Alberta, it has now spread north-west into Alaska. The method adopted by the Control officials (of whom there are no fewer than 145 in Wyoming alone) is to lay a central bait of unpoisoned meat in some convenient station. From that centre long avenues formed by little baits of fat poisoned with strychnine radiate in all directions. The coyote is shy and cunning ; it never goes straight through to the chief bait, but approaches in circles. In the course of its circles it keeps

on meeting with the pieces of poisoned fat, and sooner or later yields to the temptation to try one. In this way enormous numbers of coyote have been killed; to give an idea of the slaughter, 50,000 of the bodies were recovered in the five years 1924-8 for an examination of the stomach contents. That can hardly be more than a fifth of the total killed in the same period. It is claimed that this strychnine method entails but little risk to other less destructive fur-bearing species because they usually go straight through to the fresh unpoisoned meat, and the poisoned fat-baits are collected after the coyote operations are concluded in any given district and, if lost, soon break up under the sun and become inedible. But the fact remains that many thousands of foxes, badgers, skunks, racoons, minks, and other desirable and perfectly harmless animals have been destroyed by the coyote campaign. Nobody denies that the coyote does occasionally great damage to sheep and lambs, and sometimes kills calves, colts, and even full-grown deer; but that is the work of a comparatively few individuals. The staple food of the vast majority is rodents. And the great destruction of carnivorous life which has taken place in the United States continuously from 1916 to 1930 and later has been followed by a steady and alarming rise in the rodent population. It is necessary to remark that birds too have suffered, in addition to Carnivora; thus in one year 5,000 magpies had to be poisoned as a preliminary because they interfered with traps laid for coyotes. How many other species suffered at the same time is not recorded. The only comment I will trust myself to make is that this does not seem to be quite the right way to control an occasionally destructive mammal.

Now I pass to problems of very much greater difficulty. The giants sometimes vex us, but the dwarfs threaten our existence. Rats and mice of many kinds, rabbits, and hares, squirrels, sousliks, and marmots, and many other small mammals are really terrible things when they get out of their right stations and out of control. They inflict vast annual pecuniary losses upon the entire world, and from time to time they kill humanity like flies. In ten years they may do more damage to us than all the Carnivora and Ungulata together could do in ten centuries. And the galling part of the whole business is that in the majority of cases when we suffer injury of this kind we have only to thank our own folly for all our troubles. I hasten to say that here again crude methods of extermination will not afford a satisfactory remedy. Nature is as resourceful as a woman's wit, according to Rosalind. Exterminate a species now giving us a lot of trouble because we have been careless and short-sighted, and remain

still a little careless and short-sighted, and we shall have done no more than open the door for another species to come in and plague us. Exterminate the genus, the family, the order, or even the class, and there are still hosts of beings ready to seize upon the vacant places. What the result would be no man can tell; but our last condition might very well be worse than our first. It is better by far to live with the devils you do know than with the devils you don't know.

The small mammal problem arises nearly always, and in all countries, as the direct result of human enterprise. Small mammals are not noxious things in themselves; in their right stations, in their own homes, and in proper numbers, they have their own share of the great task of running this world to perform. No instructed man can point a finger at one of them—not even at the Black Rat or the Common Rat—and say with certainty that that species ought to be exterminated. The most he can say is that it should be kept in its proper place. If we take a broad yet rather close view of the great and important group of myomorphous rodents, we shall find that all are endowed with a high rate of fecundity, that all are fond of peace, security, and plenty, and that, with very few exceptions, no matter how specialized the habits and station, all are capable of adapting themselves and of adjusting their habits to novel surroundings. They are educable to a degree, and among them the rank and file are quick to follow the lead of the more enterprising or inquisitive individuals. Of course this does not apply to all the thousands of known species with equal force. Educability is developed by experience, and the House Mouse, Black Rat, and Common Rat, which have been longest in contact with civilized man, surpass all the others at the present moment in their power of exploiting human activities and of eluding human vigilance. With these things in mind it is quite easy to see how certain once innocent species have become dangerous pests, and how species now innocent will in turn become noxious if given an opportunity. With Lady Wishfort, one is tempted to ask, 'What is integrity to opportunity'.

The high rate of fecundity (coupled with the rapid growth and ripening of the individuals) is the mainspring of the whole business. So many more are born than can possibly survive that there is in each species as it were a great driving force which impels it to colonize every accessible vacant place that will afford it harbourage and sustenance. In purely natural conditions, which, alas! now exist in very few places in the world, the food and space available for any given species of rodent are strictly limited. These limits, the presence of competitive species, the presence of all kinds of carnivorous enemies, the weather, and, in the last resort, if all

else fails, the existence of disease, form together the stern bonds by which nature keeps the species comfortably in its place. Of course, even in purely natural conditions things may sometimes go wrong. Some accident may temporarily provide the undue increase of some favourite food-plant, a competitor may be hard hit, carnivorous enemies may have been temporarily weakened, the weather unduly lenient, or disease temporarily dormant; one of these things, or some or all of them in combination, may for the time unduly favour a particular rodent, and then its numbers will rise far above the number which represents the real capacity of the area inhabited. There is, of course, too, evidence, brought together largely by Elton, of a periodicity or rhythm in the fluctuating numbers of rodents; but with that I will deal a little later, merely remarking now that in some cases, at all events, that rhythm may itself be in part due to human interference. But to whatever cause the abnormal rise in numbers may be due, nature sooner or later steps in, tightens her bonds on the species, and removes the surplus. Sometimes the cure is so sharp that after the swarm has passed away the species will become very rare on its old ground, its numbers diminished far below the normal representation. It may then take months or years to recover: and if at this moment of extreme decline an attack be made upon it, by the arrival of a strong, vigorous competitor, the advent of a hard winter, or some other adversity, it may become totally extinct.

Now when man comes along he at once deranges this natural mechanism. He cannot get at the mainspring, high fecundity, but he weakens the escapement, that is the controls devised by nature. In fact, for some quite unintentionally favoured species he has destroyed the whole escapement with the exception of the absolute limits imposed by food and space and the liability to disease. The destruction of the forests, the clearing of the ground for agriculture and sport, the cultivation of food-plants, the breeding of live stock, the building of houses and sheds, the establishment of villages, towns, and cities, the construction of roads, railways, canals, and sewers, of shipping and ports, and the development of commercial relations between all the countries of the world, have enlarged, beyond all reasonable bounds, the food and space and the shelter available for those rodents able to take advantage of such improvements. At the same time we have greatly diminished the space available for carnivorous animals of all kinds, we have relentlessly persecuted all the carnivorous mammals whose interests occasionally seemed to conflict with our own, and we have hunted every fur-bearing species in all parts of the world, wherever possible, to the point of extinction or something dangerously

close to it. By these means we have greatly weakened the rodent resistance of the country-side in all parts of the world ; and then, adding insult to injury, we discount the real value of what we have destroyed by saying, ' Of course Carnivora were never able to prevent rat and mouse plagues ', basing that assertion upon observations in such notoriously over-hunted countries as Norway or North America.

But that is not all. We have been building, for thousands of years, cities in all parts of the world, and until quite recent times no attempt was ever made to make even the most important buildings rat-proof. Obviously in such places rodents are secure from ordinary carnivorous foes and from the weather. Many, of course, fall to the domestic cat and dog ; some to the ferret and rat-catcher. Many are trapped or poisoned ; but they are educable, and quick to learn how to avoid danger of all kinds. The recent great experiment of rat-proofing in this country has had a laughable but, it may be, in the end a very serious result. Comedy is never far removed from tragedy.

The House Mouse, The House Rat (*Rattus rattus*), and the Common Rat (*Rattus norvegicus*) are Asiatic species, which have wandered all over the world with man. Nobody knows when the House Mouse arrived in western Europe, but it has been in these islands at least since neolithic times. There has been a great deal of uncertainty as to whether either of the two rats was known to the ancients ; but I think the Greeks must have known both. As regards the Romans, I have put on the table three bronze statuettes from a first century A.D. site near the palace of the Caesars in Rome. These, formerly in the Martinelli Collection, were given to me very generously by the late Dr. Sambon, in gentle refutation of one of my earlier rasher published opinions. One of the statuettes certainly looks like a *Rattus rattus*, and the other (on a smaller scale) like *R. norvegicus*. What species the third represents I am not prepared to guess. They, and the fact that the Greeks trained the marten for use as a house-cat, are at any rate satisfactory evidence of the great antiquity of the rat and mouse problem in Europe. As regards western Europe, and Britain in particular, there is no doubt that the first rat to arrive was *Rattus rattus*. It came here probably about the time of the Norman Conquest or the first Crusade, and for hundreds of years, down to the beginning of the eighteenth century, it was the only rat infesting our houses and shipping. It was the species primarily responsible for the outbreak of bubonic plague, the black death which ravaged mediaeval Europe and culminated in our own great plague of 1665-6 ; and it is the species still chiefly responsible for the outbreaks of plague which occur in India

and other warm countries. The arrival here of the Brown or Common Rat (*R. norvegicus*) in the early part of the eighteenth century was a very important event. Being a much more vigorous and hardier species, one that originated on the open plains of Central Asia instead of in the forests of India and the Malay Peninsula, it was not at all dependent upon human shelter as a protection from our trying climate; whereas *R. rattus* could not get through a single winter without our houses and other buildings. Once the Brown Rat obtained a footing in the country no means of ejecting it could be devised. It quickly spread all over the country, using the rivers and canals chiefly as its highways. From the stream side it entered the drains, and from the drains it entered the basements of the houses. Passing upwards from the basements, it went, floor by floor, up to the garrets. This triumphal progress occupied about a century; and it resulted in the practical extinction of the relatively weak and delicate *R. rattus*. At the end of the nineteenth century the latter could only be found on our ships, where its gymnastic accomplishments gave it an advantage, and on the top floors of certain solidly built granaries and breweries in some of our large ports. In such places small and temporary colonies were formed from time to time, the Black Rats being introduced with the cargoes from grain ships. I remember the interest which an alleged Old English Black Rat excited when exhibited at a meeting of the Essex Field Club in 1899; it was really only a melanistic *R. norvegicus*.

In the present century we began to re-build central London. We could no longer be content with the shabby old streets in which our fathers made their fortunes; so we built a series of great palaces, in which the seeds of bankruptcy and traffic congestion could be sown with sufficient dignity. People were rather disgusted with the Brown Rat; they began to realize that it cost an awful lot to keep it in the millions which then infested London, and it was not really hygienic to have droves of them in the kitchens of every eating-house coming in laden with filth from the common sewers. So in these new buildings a great and a most successful effort was made to make the basements and ground floors rat-proof. To indicate the success of this experiment against the Brown Rat, I will merely tell you that in one prominent street the new buildings remain for the most part quite free from this pest, although from an adjoining older building as many as 5,000 *R. norvegicus* were taken recently in the course of six months. In the course of my nocturnal wanderings in the city I have often seen droves of them scurrying across the road from one warehouse to another in some of the less frequented lanes towards the river. Similar changes have taken place in many other British cities with precisely similar results.

We are thus shutting out the Brown Rat (*R. norvegicus*)—a step in the right direction. But in doing that we are re-opening the door to *R. rattus*. That poor creature has been clamouring to deaf ears for re-admittance to our land for a century, but in the face of its rival it could do nothing without our assistance. But at last we have done the really handsome thing. We have shut the rival out, established lovely attractive kitchens on the roofs fitted with plenty of nice open sky-lights, and we have linked up roof and roof, and bridged the horrid streets with a lovely net-work of telephone wires and cables. No primitively arboreal species could imagine a nearer approach to paradise. Every night there is a procession along these cables and over the roofs : new colonies are established in every possible place. *R. rattus* is now once more the Common Rat in many parts of our great city. To show how quickly it works :—Bankers move in to a brand new building on Monday ; on Wednesday they think they have rats. During the week-end the backs are eaten off many of the new books, and on the following Wednesday the rat-catcher takes more than sixty out of the up-to-date roof-kitchen. We are thus fast getting back to the state of affairs which existed in the seventeenth century not only in London, but in many other of the larger ports. If this goes on we shall certainly be once more in peril of plague. Improved sanitation has little or nothing to do with it. The one great obstacle in the way of a recrudescence of plague is that so few people now sleep in the city ; that nightly exodus means safety. But what would happen if the Black Rat were to get a footing in the crowded dock-side slums of our great ports I tremble to think. It has, fortunately, not come to that yet, and if we take care to devise means of protecting the roofs and do our best to banish the Black Rat once more from our cities the pest will be averted.

In these facts you see great biological principles at work—principles which I will not endeavour to formulate. But the rider to them would be : ‘ If you create a vacancy, it is your own very difficult business to keep it vacant.’

Now I want to say something about a remarkable scheme devised originally by Mr. Rodier, primarily for the extermination of rabbits in Australia, but stated to be equally effective against rats both by Rodier himself and by his great British champion Mr. Jennison. The theory has been propounded in a series of curious circulars, many editions of which during the last twenty-five years have been distributed all over the world. Mr. Jennison has written two or three papers, his last statement on the subject being published so recently as 5 March last in the ‘ Field ’. As I understand the scheme it is shortly this :—You catch all the rats alive ; you determine the sex,

kill the females, and liberate the males. In this way you create a superabundance of males and a great dearth of females. The males will then so pursue and harry the females that the latter will be unable to nurse their young or else will be worried to death without producing any young at all, and so the species attacked by this Rodier method will become extinct. Mr. Jennison experimented with this system for fifteen years at the Belle Vue Zoological Gardens at Manchester. There he claims to have reduced the rat population in that time by one-third by this procedure. This does not seem to be a very startling success; for if one had surrounded the Gardens with a rat-proof fence and then started an intensive campaign of ordinary indiscriminate slaughter, one might easily, in the course of fifteen years, have exterminated the lot. But I do not know how one measures one-third of the rat population. If it is by an inference drawn from the gradually declining catches in the live traps used, then I think the inference is unsound, because declining catches may indicate no more than that, as highly educable animals, the rats became progressively more and more wary. Many of the males were probably caught more than once in the earlier stages of the experiments, and their hearty dislike for Mr. Jennison and his experiments would be gradually but surely communicated to the whole colony. In the end, as Darwin once put it, only the feeble-minded rats of both sexes would go into the traps. But however the measuring was made, an apparent one-third decline would be well within the reach of the effects of educability produced in the course of fifteen years.

But the theory is open to a much graver objection. It rests on a fundamental misconception. It is assumed by Rodier and Jennison that the male rats are salacious creatures. That is entirely wrong. It is true that rats possess, like most other rodents, great fecundity, but they are not in the least salacious. Except for a few hours at regularly recurring intervals, when the females experience heat, the females have no attraction whatever for the male. At all other times males and females live together merely as comrades, without showing the slightest sign of sexual excitement or desire. They are eminently sociable animals, not given to fighting at all; so much is this the case that if you have more than three in a sack, unwounded and comfortably settled of course, you can, if you have sufficient courage, put your hand in and handle them with safety. The hand passes muster in the crowd as another comrade, and is so accepted. When a female comes on heat she is immediately covered by the nearest male, sometimes by five or six of them in succession, until heat subsides. There is a succession of shrill squeaks from the pairing couple, but there is no fighting and no combat

for the privilege like that which one sees in dogs and many other of the higher mammals. In due course the female withdraws to her nest, gives birth to her young, and within a few hours comes on heat again. On these facts, therefore, the only result of an application of the Rodier system to rats would seem to be to ensure that every female would find a satisfactory mate on every possible occasion.

It is always dangerous to argue by analogies from one class to another. On two or three occasions Mr. Jennison has cited the case of the Passenger Pigeon as an instance of the efficacy of the Rodier treatment. In his latest note he says: 'The Passenger Pigeon of the United States and Canada was exterminated through the mere chance that in collecting squabs for food many adult females and few adult males were killed; compared with their numbers, our starlings [to which Mr. Jennison would apply Rodier treatment] are as nothing.'

Now I do not believe there is the slightest evidence for the assertion that adult females were killed in such excessive numbers as to disturb the sex ratio. As everybody knows, enormous flocks of these birds used to migrate in search of food in the spring from the southern United States northwards into Canada. These flights were not on the same vast scale in every year; it was only at intervals that grand flights took place. They are known to have occurred at least as far back as the end of the seventeenth century, for we find a bishop cursing the birds as demons for the ravages committed by them on the colonists' crops near Montreal in 1687. One of the last flights, at least in eastern North America, occurred in the spring of 1869 or 1870, and of this an eye-witness account has been published in 'The Ibis' 1922 by my friend Dr. Lowe. The eye-witness, Dr. Welford, tells us how in earlier years flocks of a few hundreds or thousands used to arrive each morning in his district in Ontario. The birds were very shy and difficult to approach, and the sportsman thought he had done quite well if he bagged eight or ten in a day; as Dr. Welford put it, 'a right and left' was all you got and the birds passed on. Rarely could you get from fifteen to twenty-five birds out of the flock. But when the great flight came, in 1869 or 1870, the air was black with flock upon flock. In the pressure the birds could not maintain their shyness, and Dr. Welford bagged more than 400 on the first day before 10 o'clock in the morning. The flight went on all day, day after day, for a week, the birds darkening the sun, until the flight was over. For several years after this flights continued, but in greatly reduced numbers, and finally they ceased altogether, and the species became extinct.

Many other cases of this kind are known. Among mammals we have a remarkably close parallel in the Springbok of South Africa. Periodically the numbers of this animal would swell to amazing heights, and the ordinary food migrations were turned into floods of closely packed antelopes which swept away fences, crops, flocks, and herds as they rushed over the plains. One of these closely packed masses is said to have extended continuously through a space of country measuring 138 by 15 miles. One of the last of these great treks was seen in 1896, and of this a very good account has been published by Mr. Cronwright-Schreiner. After that the species became scarce, and had it not been for the fact that certain farmers resolved to protect it and treat it as a more or less domestic species, the Springbok would by now have become extinct. At any rate, there are no perfectly wild herds left.

Parallels are seen also among lemmings, voles, and other mice, among hares and rabbits, squirrels, and many other rodents. In all we get these periodical vast increases of numbers followed by sharp declines, during which the species become very rare and in certain conditions extinct. If extinction does not happen, the population sooner or later rises again to a peak. During the peak, creatures which, like many voles, have in normal conditions a strong sense of property or territory and a dislike for rubbing shoulders, are forced to abandon their ordinary habits and prejudices, and they become as closely packed as the dwellers in our slums or as the rats in our sewers. As food becomes more difficult to find for the ever-growing swarm, nocturnal and crepuscular species become diurnal; the most timid forms lose all shyness, so that species which normally would not let a man approach within many yards or even a mile of them (according to the perfection of their senses) now will run over him.

What is the explanation of these astonishing rises in numbers? It cannot be doubted that in some way the phenomenon is connected with nutrition; but a mere abundance of food, peculiarly suited to the development of the hormones stimulating sexual and reproductive activity, is not enough; space in which the peak can rise, favourable weather, absence of enemies and freedom from disease are all important factors. There has been much research of all kinds upon the subject of reproduction and upon the conditions which govern the fluctuations which we observe. Thus, in the last number of the 'Proceedings' of the Royal Society we find Messrs. Baker and Rawson describing their experiments on captive voles (*Microtus agrestis*); their work tends to show that if you shorten the daily period of exposure to light

from fifteen hours to nine you almost prevent reproduction in this species ; it is the female which is chiefly affected. Now all this work on gonads, hormones, vitamins, light, temperature, and humidity is very ingenious and very interesting, and that it is throwing a great light on the precise mechanism by which food and environment influence the reproductive forces of animals cannot be doubted. But I do doubt very much whether it will lead to any serious modification of the great general principles which have long been recognized. It does not need a ghost from the laboratory to tell us in April that the return of the sun favours reproduction and growth.

To sum up. I think that the clearance of the world for agriculture, the cultivation of highly nutritious food plants, and the extermination of carnivorous animals and birds and other competing forms of life are the things which have led chiefly to the production of swarms of passenger pigeons, springboks, migratory lemmings, vole plagues, etc. In the Kaibab Park we saw the same thing beginning with the deer. In all these cases we are dealing with animals in their own homes, surrounded by all sorts of natural checks upon their increase which we have so far been unable to tamper with, and unable to appreciate. When we introduce new species into countries where we have done damage of the kind described, we see how real these other intangible and unappreciated natural checks are. Rabbits in Australia, musk rats in central Europe, and now, unfortunately, in Britain, rub the truth of this view well home.

Finally, man must, in order to feed himself, interfere with the face of the earth. But he should be alive to the possible consequences of that interference. In every community actions of these kinds should be guided by biological experience and opinion. Watchfulness upon the great openings which we create for enterprising animals is what is chiefly needed ; we should be quick to prevent if we wish to control. And we should not attempt control by crude extermination.

After the PRESIDENT had expressed the thanks of the meeting to Mr. Hinton, a discussion followed, and Mr. Hinton replied.

Dr. FISHER said he would like to express his appreciation of the scientific value and general interest of Mr. Hinton's paper. With respect to the K.O.F. (kill only females) campaign, he believed that everyone would agree with Mr. Hinton's strictures on the sensational statements which had been circulated. He was not sure, however, that Mr. Hinton had been entirely fair to the promoters of the movement in stating that the *only* effect of an excess of males would be to ensure the immediate fertilization of all female rats ready to be fertilized. Some observations which the speaker had been

led to make during the last few years upon a colony of mice, which he had kept for genetical purposes, seemed to show that other effects would be not improbable.

For the purposes of his experiments it had been necessary that the successive litters of each doe should be sired always by different bucks. At first he had tried waiting till the litter had been born before changing the buck. But this course had been quickly found to be disastrous. Mice appeared to have a strong sense of territory, and the doe usually flew at the intruder, who, for his part, defended himself very meekly, and displayed every anxiety to escape. If, after they had settled down, they were left for the night, it was found in the morning that the litter had been slaughtered, and was being quietly eaten by both adults. It was considerably safer to introduce the doe and her litter into the buck's cage, for his infanticidal instinct appeared to be conditioned chiefly by finding himself on alien territory.

In the light of these facts the practice had been next adopted of changing the bucks before the litter was born, in fact as soon as the pregnancy could be detected, so as to give the buck introduced as long as possible to settle down, and 'feel at home' in his new surroundings. It was particularly interesting that this plan worked well for old bucks, but generally failed when a young buck was introduced into the experiment. The infanticidal instinct was, in fact, very finely adapted to the biological needs of the male mouse. If a buck, which had been capable of engendering for only ten days, were confronted with a litter which had been begotten certainly as long as nineteen days ago, calculation might show him that he could not be its father. In practice he might not do the calculation, but he did slaughter the litter.

Wild bucks certainly possessed the same instinct. Until recently, before the old cages had been replaced, the first sign of an incursion by a wild buck had been always the loss of one or more litters already born, and often, what was equally annoying, the replacement of the next experimental litter by one of obviously wild parentage. The small rodents, as Mr. Hinton had said, were undoubtedly not salacious animals. But the mice at least, in the speaker's experience, had unquestionable infanticidal instincts, and, without knowing what practical successes the method could claim, the speaker suggested that it could more fairly be judged by its success in *practice* than by the rather absurd *theories* of how it was supposed to act.

Mr. G. C. ROBSON commented on the importance of Mr. Hinton's paper from the evolutionary point of view, and enquired if Mr. Hinton knew of any good instances, among mammals, of radical changes in habits occurring as the result of over-population.

Sir SIDNEY HARMER expressed his regret that the Prime Minister and the principal administrators of the Dominions and Colonial Services had not been present to hear Mr. Hinton's admirable exposition of the possible danger of attempts to acclimatize animals in new areas. He referred to previous correspondence with the British Museum (Natural History) on the subject of the Rodier method of reducing the numbers of rats and other small mammals, and he reminded the Society of the Hooker Lecture on the Swiss National Park which was delivered in the Society's lecture-room on 15 April 1926. In this lecture Professor Carl Schroeter had made the following statement :—' The preservation of certain beasts of prey is requisite as a hygienic measure, as they kill sick animals first ; in one place foxes had been exterminated, and an epidemic amongst hares set in, so that foxes had to be re-introduced ' (Proc. Linn. Soc. 138th Session, p. 44).

The following paper was read in title :—

' Reports of an Expedition to Paraguay and Brazil in 1926-7, supported by the Trustees of the Percy Sladen Memorial Fund and the Executive Committee of the Carnegie Trust for the Universities of Scotland.—Nematoda.'
By Dr. H. A. KREIS.

28 APRIL 1932

Professor F. E. WEISS, F.R.S., President,
in the Chair

The Proceedings of the General Meeting held on Thursday, 14 April 1932, having been circulated, were taken as read and confirmed.

A list of names of those who had made gifts to the Library since the previous meeting was read and laid on the table.

Certificates of recommendation of the following candidates for Fellowship were read :—For the second time, in favour of George Francis Scott Elliot and Martin Audley Foquett Sutton ; for the first time, in favour of Raghunath Prasad Asthana and Abdus Sattar.

The cause of petaloid colouring in 'apetalous' flowers.
By Miss E. R. Saunders.

MISS SAUNDERS stated with reference to the title of her paper that she intended 'cause' to be taken to signify the more immediate or proximal cause, and that among plants

with 'apetalous' flowers she would include all Dicotyledon types with a single perianth.

In the greater number of monochlamydeous types the members of the perianth (conveniently indicated by the term tepals) are petaloid (coloured or white); in a minority they are green, like the sepals.

A study of the vascular anatomy of a number of dichlamydeous types showed that they could be divided into two groups. In the one group the marginal veins of the sepals are derived by lateral branching from the midrib; in the other these veins most frequently arise from commissural trunk cords, that is to say, from trunk cords which turn out from the central cylinder on the alternate or petal set of radii. Each of these trunk cords forks to furnish two marginal veins. Each carries out, conjoined with these two bundles, the midrib bundle for the petal of the corresponding radius, sometimes also, the bundle for the antepetalous stamen on that radius. As the trunk cord passes to the periphery it becomes resolved into its components, the two marginal bundles passing to the sepal to right and left respectively.

A similar investigation carried out upon monochlamydeous types showed that they likewise can be grouped into two classes. In the members of the one class the vascular system of the tepal is derived entirely from elements in the central cylinder lying within the limits of the tepal sector, the midrib being formed from elements in the centre of the sector, marginal veins (if present) arising generally as lateral branches from the midrib, exceptionally as distinct strands from elements lying alongside those giving rise to the midrib. In those of the other class the midrib is derived as before, but the marginals are commissural in origin, arising either separately or conjoined in pairs from a point or points in the central cylinder lying within the limits of the sectors alternating with those of the tepals.

It was found that in plants belonging to the first class the tepals were green (non-petaloid); in those of the second class they were petaloid (non-green). There thus appears to be a definite relation between the vascular ground-plan and the general colouring of the tepal.

A survey of the whole body of evidence leads to the further general conclusions:—

(1) That the complex of characters which are implied by the terms sepaline and petaline respectively are laid down in definite relation to time and space in the typical cyclic flower, the sepaline appearing first, the petaline later, and on radii that alternate with those of the sepals irrespective of the particular planes in which these members may lie.

(2) That the individual members of the single perianth

are not morphologically equivalent in all types. The tepals of the green perianth correspond to sepals: those of the petaloid perianth are the counterpart of a single sepal + half the neighbouring petal on either side.

Dr. A. B. RENDLE said that the correlation indicated between the colour of the perianth in monochlamydeous flowers and the course of the vascular bundles was very remarkable. He asked whether in *Deherainia* cited by Miss Saunders the green colour was due to chlorophyll, and pointed out that green petals were not invariably coloured by the chlorophyll pigment, as, for instance, in *Ixia viridiflora*, where no pigment was present.

Sir SIDNEY HARMER asked Miss Saunders whether she could explain the coloration of *Helleborus viridis*, in which the calyx is green, although it is white or coloured in certain other species of the genus.

Professor R. R. GATES expressed much interest in Miss Saunders's results, and stated that the only similar case that occurred to him, of correlation between vascular anatomy and pigmentation, was in an *Oenothera* mutation. *O. rubricalyx* appeared as a dominant mutation from *O. rubrinervis* in 1907. In the buds of the latter the midvein of the sepals (which contains a vascular bundle) is invariably green, as is also the hypanthium. In *rubricalyx* this midvein is deep red, and the hypanthium as well. This case is of particular interest, as the evidence indicates clearly that *rubricalyx* arose as a gene mutation.

Dr. T. A. SPRAGUE pointed out with reference to Miss Saunders's view that a *commissural* origin of the marginal veins of the tepals in Monochlamydeae indicated that these tepals were morphologically compound (the median part being sepaline and the margins petaline), that a similar origin of the marginal veins was found in the *sepals* of numerous dichlamydeous plants such as *Hibiscus*. Since it is generally agreed that many Monochlamydeae have been derived from dichlamydeous ancestors by loss of the corolla, such tepals might be wholly sepaline, and the hypothesis that they were partly sepaline and partly petaline seemed unnecessary. He suggested that useful evidence might be afforded by the study of monochlamydeous members of characteristically dichlamydeous groups, e.g. *Chrysosplenium*, in the Saxifragaceae.

The PRESIDENT, in thanking Miss Saunders for her interesting communication and exhibits, considered the results arrived at to be of fundamental importance. If the views put forward proved to have a more general application they might considerably modify accepted interpretations of floral

morphology. He hoped Miss Saunders would extend her observations to other groups of plants.

Dr. E. N. MILES THOMAS asked whether Miss Saunders had considered the application of experimental treatment, as, for instance, the severing or plugging of the commissural veins associated with coloured apetalý.

Miss SAUNDERS replied.

On the alleged larvicidal property of *Chara fragilis*.

By Mr. T. B. Blow.

FROM the 'American Journal of Hygiene', vii (1928), p. 279, it appears that Messrs. Matheson and Hinman began a series of observations on *Chara fragilis* in connection with mosquitos in 1923, and commenced the tests in 1925.

Further tests were made by these workers, the results being published in the 'American Journal of Tropical Medicine', ix (1929). Without going into details of the very extensive tests applied, it may be stated that their conclusions were that '*Chara fragilis*, growing in still- and running-water aquaria of various kinds, prevented mosquito breeding. In the presence of decay oviposition takes place, and larval development proceeds normally. If the plant recovers its vigorous growth the decay ceases. larval growth is inhibited, and oviposition does not take place'.

These conclusions came as a great surprise to British investigators, who had used many species of Charophyta as tests (in my case six species). None of them, however, appeared to have tested *Chara fragilis*, though I had used, with negative results, *C. delicatula*, a very near relative of *C. fragilis*, of which some botanists regard it as a subspecies. Thanks to the kindness of Colonel Barnardiston, I obtained an ample supply of *Chara fragilis* proper, and when it had grown vigorously in two of my large glass jars introduced larvae of *Culex pipiens* and *Theobaldia annulata*: they enjoyed a vigorous life, between 80 and 90 per cent assuming the winged state.

It will be remembered that Mr. Pal, in his paper on Charophyta of Burma, read before the Society on 22 January 1931, drew attention to the destruction of mosquito larvae by predatory insects. I sent a copy of the abstract of Mr. Pal's paper to Dr. Hamlyn-Harris, the City Entomologist of Brisbane, Queensland, whom I have known for many years as a careful investigator of this subject, and of *Chara fragilis* in particular, and the following is a copy of a letter sent to Mr. Pal:—

'Some little time ago Mr. T. B. Blow of Welwyn sent me your abstract on Burmese Charophyta, read before the Linnean Society of London, and I thought the following notes

might interest you. Some recent experiments with *Chara fragilis* have interested me very much, and have some bearing on the economic importance of your own investigation. Some time ago I instituted a number of experiments with jars containing:—(1) *Chara fragilis* growing normally, and (2) *Chara fragilis* in the state of decomposition, (3) *Hydrilla* and *Ceratophyllum*, (4) *Nitella gelatinosa*. Though these jars were all situated within a few feet of one another, the extraordinary thing is that the first jar to be selected was a large earthenware vessel, containing about a gallon and a half of water, and a fine growth of *Chara fragilis*. The mosquito to select it was *Aedes argenteus*, of which the first three pupae hatched within a period of ten days. Then came a further surprise: *Culex fatigans* selected a glass jar containing a smaller quantity of water, but a more luxuriant growth of *Chara fragilis* than was contained in any of them. Two egg-rafts were laid on this water. Some hatched out into adults quite normally, but the greater majority of larvae fell a prey to, first of all, the attacks of the species of *Hydra* present in considerable numbers; the young larvae could be seen quite distinctly inside the central cavity when viewed in certain lights: secondly, the remainder of the first egg-raft was attacked by a species of *Saprolegnia*, which killed off the larvae so attacked. None of the other jars, not even the controls, were selected. It does seem strange to think that these two jars should have been the only ones selected, and in face of such facts how can I possibly accept Matheson and Hinman's statement that "under every condition *Chara fragilis* is larvicidal". I never make these observations without showing them to responsible people, so that they are able to judge for themselves. In this particular instance my witness was Dr. Graham Drew, the Deputy Commissioner of Public Health, Queensland.

I may here note that Dr. Hamlyn-Harris has several articles on the subject in the 'Proceedings' of the Royal Society of Queensland, notably in vol. xli, no. 3, in which he gives a long account of the various predatory insects which prey on the Mosquito larvae.

In a later letter to me Dr. Hamlyn-Harris said:—'My latest researches into the efficiency or otherwise of the Charophyta as possessing larvicidal property only confirmed what I said all along. To my mind they are utterly useless in mosquito control. In the laboratory conditions are so abnormal that one finds that they breed sometimes, and sometimes they do not; but I have proved experimentally that by providing supplemental food *Culex fatigans* can be induced to breed in overwhelming numbers. I am further of opinion that Professor Matheson's interpretations of his

findings are inadequate, because he has entirely ignored certain chemical phases of the question which may be responsible for the conditions which he obtained, such as the decrease of CO₂, the increase of carbonate due to the temperature of water, according to the time of day: therefore I do not believe that the Characeae have anything to do with the conditions which he attributes to them. This briefly, in a nutshell, is, I fancy, all you need to know. If you require any further information, please write, and I will communicate with you further on the subject.'

I think from what I say in this paper about *Chara fragilis*, and with the corroborative evidence of Dr. Hamlyn-Harris, that it may safely be concluded that that species, in common with Charophyta collectively, has no larvicidal qualities.

Mr. G. FOX WILSON, with reference to the reputed toxic action of certain species of *Chara* on mosquito larvae, pointed out that an interesting statement is made by John Lindley in 'The Vegetable Kingdom' (1847, p. 28), viz.: 'The fetid effluvium arising from them (i.e. *Chara* growths) is regarded as very unhealthy, and one of the sources of the malaria of the Campagna of Rome'.

McGregor in 1924 ('Parasitology', vol. xvi, pp. 382-7) tested the effect of *C. foetida* and *C. hispida* on the development of mosquito larvae. These two species are said to possess distinct larvicidal properties, though this was not found to be correct.

While engaged in anti-malarial work in the Suez Canal area in 1917, it was observed that a favoured habitat of Anopheline larvae (*Anopheles pharoensis* Theobald) in Lake Kasa, west of Kantara Station, was amongst the matted growths of *Chara* (*polycantha* Braun.?). This lake was fed by an overflow from the Sweet-Water Canal, about three miles south-west of Kantara, and was connected with the larger Lake Menzaleh, whose waters are brackish. The waters of Lake Kasa are fresh, the salinity expressed in terms of parts of common salt per 100,000 varied between 1.74 and 2.91 (2.27 mean). The period of active growth of the *Chara* weed was from August to November (1917 to 1918).

The lake abounded in larvivorous fish, particularly 'Bolte' (*Tilapia nilotica*), but they were unable to approach the Anopheline larvae by reason of the impenetrable mass of *Chara*, while many fish were actually trapped amongst the growths. These fish were found to be useless for destroying mosquito larvae, not only amongst the masses of *Chara*, but they also failed to clear the larvae from areas of reeds—*Phragmites communis* and *Typha* spp. These fish were useful, however, under artificial conditions. For instance,

camel tracks situated by the lake-side became flooded, and in them mosquito breeding was intensive. It was a simple operation to form channels from the lake so that fish had free access to the tracks, with the result that the larvae, unprotected as they were by vegetation, were eaten with avidity.

The whole question whether *Chara* possesses any larvicidal properties is not clear, though it is certain that some species are devoid of any toxicity.

Great care must be exercised in carrying out tests, especially under laboratory conditions, for it must be remembered that certain mosquito larvae prefer water with an acid reaction, others with an alkaline, while others show greater tolerance and live equally well in both acid and alkaline waters. Laboratory conditions are not always ideal for the breeding of mosquitoes, and more conclusive evidence is required before this matter as to the toxicity of *Chara* to mosquito larvae is cleared up entirely.

The PRESIDENT expressed his interest in Mr. Blow's communication, and stated that the further observations made by Mr. Fox Wilson in Egypt confirmed Mr. Blow's opinion that there was no larvicidal quality in *Chara*. On the contrary, *Chara* would seem sometimes to prevent the destruction of the mosquito larvae by fish.

Mr. J. RAMSBOTTOM commented on Mr. Fox Wilson's point about laboratory conditions. It was stated in Dr. Hamlyn-Harris's letter that *Saprolegnia* killed some of the larvae. This was a common experience in the laboratory of the Anti-Malarial Unit at Salonika, though it could not be said that *Saprolegnia* in the wild had any apparent influence in limiting the myriads of mosquito larvae.

Biology of the African Lakes.

By Dr. E. B. Worthington.

THE lecture was intended to introduce the scientific results of the Cambridge Expedition to the East African Lakes, which are to be published as a series of papers in the Society's Journal.

Rifting and warping movements of the earth's crust, volcanic activity, and the pluvial periods, which were contemporaneous with the European glaciations, have done much to change the drainage systems of East and Central Africa. One of the objects of the expedition was to help to disentangle these geological questions by evidence from the distribution of aquatic fauna and flora, both living and fossil.

Originally Central Africa was a simple dome or geanticline, its summit about the present east shore of Lake Victoria, with streams running east to the Indian Ocean, the remnants

of which are the Tana and Athi Rivers, and westward across Uganda to the Congo, and so to the Atlantic, the remnants of which are a series of rivers between Lakes Edward and Victoria. These have been partly reversed by the sinking of the Lake Victoria depression, and now arise in swamps, and flow in both directions, east to Lake Edward and west to Lake Victoria.

The White Nile has now two important sources—Lake Victoria via the Victoria Nile, and Lake Edward via the River Semliki, but evidence was adduced to show that Lake Edward was completely dried up during the arid interpluvial period. This desiccation caused the extinction of the old Edward fauna, and accounts for the fact that crocodiles, Nile perch, &c., no longer exist in that lake. The modern fauna of Lake Edward is considered to have been derived mostly from the east, from Lake Victoria, during the second pluvial period, and the faunistic distribution is in favour of this hypothesis. For instance, the expedition's collections have shown that there is one species of *Barbus* common to Victoria, Edward, and Kivu, with subspecies in each lake. Lake Kivu now drains into Lake Tanganyika and the Congo, so that this piece of evidence corroborates the geological conclusion that Lake Kivu formerly drained north to Lake Edward and the Nile, until the growth of the Mfumbiro volcanoes ponded the valley and caused it to overflow to the south. The eastern Rift Valley lakes now lie in closed drainage basins, but the fauna and geology of Lake Rudolf show it to have been connected to the Lower Nile during the pluvials.

Passing to ecological results, two lakes were taken as examples. Lake Bunyoni, a very modern lake in Uganda, has no indigenous fishes, but in their absence frogs (*Xenopus laevis*) have taken to a pelagic existence, feeding on planktonic Crustacea and themselves eaten by otters and fish-eating birds. In an old lake, such as Rudolf, on the other hand, there is a complete food-chain from the phyto- and nanoplankton which depends on chemical and physical factors in the water, through Crustacea, pelagic fishes (*Engraulicypris*, sp. n.), and tiger-fish, to the Nile perch, crocodiles, and man.

Dr. G. D. HALE CARPENTER said that the Sitatunga antelope (Speke's Tragelaph) on the Sesse Isles of Lake Victoria was of very great interest. Since the removal of the inhabitants of the archipelago at the close of the last century the antelope, without any enemies to check it, had multiplied so prodigiously that by its browsing it had completely changed the character of the forests in some parts. (Photographs were shown, taken in 1926, of a typical forest scene where sitatunga had not been feeding, and another where the undergrowth had been

so browsed that bare ground and dead leaves could be seen.) During the war an American entomologist, Mr. W. F. Fiske, who was investigating tsetse fly on the islands, had said that the great increase in numbers of the buck had led to some kind of skin disease, and that he had found it difficult to obtain a perfect skin. This may have been due to dietetic deficiency, the favourite plants having been eaten down. The island specimens of this antelope live much like Bush-buck; it is usually found among papyrus, being apparently a form of Bush-buck modified for life in swamps, the hoof being more deeply splayed and longer. But on the islands it lives among the forests, and may be seen browsing where forest and grass-land meet. It was the opinion of Meinertzhagen that the island specimens were a distinct subspecies (P. Z. S. 1916, pp. 375-81).

The great increase in numbers of this animal, and the alteration in the character of the undergrowth, had had an effect upon the insect life. The numbers of *Glossina palpalis* (the species of tsetse fly abundant on the islands) seemed to have been affected by the more open character of the forests. Dr. Carpenter had found the numbers much less in 1925, on a single visit, than they had been during 1912-13, when he had resided on one island for fourteen months continuously. The butterfly fauna appeared also to have been affected. Butterflies of the nymphaline genus *Precis* on the Sesse Isles exemplified in a remarkable way the effects of climate. Species of this genus are well known to appear in different forms according to the season: the dry-season forms were formerly considered to be different species from the wet-season forms. But on the Sesse Isles the climate is more uniform than on the mainland: there is no month without some rainfall, and during the twelve months when Dr. Carpenter took records on Bugalla Isle there were about ten inches more rain than on the mainland, twenty miles to the north. The point is that all specimens save one of *Precis archesia*, an abundant insect, which Dr. Carpenter saw, were of the extreme wet-season form: the one exception was transitional to the dry-season form. *Precis sesamus* occurred in both forms, but the pink wet-season form was far more abundant than the blue dry-season form.

Dr. Carpenter said that the fishing industry on Lake Victoria, with which Dr. Worthington had dealt, had been a matter of grave concern to himself as Specialist Officer for Sleeping Sickness in Uganda. Fishing involved close contact with the tsetse fly which haunted the forested shores. Dr. Lyndhurst Duke, of the Human Trypanosomiasis Institute at Entebbe, considered that since the depopulation of the

islands, the prolonged exposure of the sitatunga to *Trypanosoma gambiense*, introduced into them by the tsetse, had resulted in loss of power of the trypanosome to live in man. After the war, over 2,000 fishermen, under careful regulation and subject to frequent medical examination, were allowed to resume fishing in their former manner. This experiment on a large scale proved completely safe: no one contracted sleeping sickness, and the islands were partially re-opened to inhabitants, under control. When Dr. Carpenter left Uganda in 1929 no case of sleeping sickness had developed, although over 6,000 people were residing on the islands, and all fishermen were constantly being bitten by *Glossina*. Great watchfulness, however, was required in case the human strain of trypanosome was re-introduced to the fly by a visitor: in these days of free communications natives from the Congo were often found in Uganda. International reciprocity was urgently needed in the control of sleeping sickness; and any measures for encouraging the supply of fish to native populations must always be framed with due regard to prevention of an epidemic of sleeping sickness.

Dr. W. A. CUNNINGTON congratulated the speaker on his lecture, and expressed the opinion that scientific results of great interest must follow from the detailed study of these African lakes. He enquired whether the results of his recent investigations would lead Dr. Worthington to predict the absence of living forms at a considerable depth in the much deeper lakes—such as, for example, Nyasa and Tanganyika.

Dr. WORTHINGTON, in replying, said that *Clarias carsoni*, introduced to Lake Bunyoni in 1919, has had little effect on the ecology of the lake, since it is restricted to the inshore weedy areas. The wholesale death of Nile perch is still a mystery. With regard to the conditions in deep water, all lakes so far examined have sufficient oxygen down to the bottom, with the exception of Edward, where there is a pronounced chemical thermocline at 60–80 m. The conditions in Lakes Tanganyika and Nyassa have yet to be examined, though there is some evidence to show that no thermocline exists as far down as 400 m. The abyssal fauna, if any, awaits discovery. In paying a tribute to Dr. Cunningham's Tanganyika expedition of 1904, the hope was expressed that a further expedition might be arranged to solve the deep-water problems.

The PRESIDENT closed the meeting with a vote of thanks to Dr. Worthington.

12 MAY 1932

Professor F. E. WEISS, F.R.S., President,
in the Chair

The Proceedings of the General Meeting held on Thursday, 28 April 1932, having been circulated, were taken as read and confirmed.

A list of names of those who had made gifts to the Library since the previous meeting was read and laid on the table.

Certificates of recommendation of the following candidates for Fellowship were read :—For the second time, in favour of Raghunath Prasad Asthana and Abdus Sattar ; for the first time, in favour of Irene Alexandra Francis Hilton, Kurumthottical Cherian Jacob, and Thomas Kenneth Rees.

The following candidates were balloted for and elected Fellows :—Benjamin Peary Pal, M.Sc., David McCall, B.Sc., Ph.D., Robert John Flintoff, The Right Hon. The Earl of Cranbrook, George Francis Scott Elliot, M.A., B.Sc., and Martin Audley Foquett Sutton.

The following candidates were balloted for and elected Foreign Members :—Professor Klas Robert Elias Fries, Professor Eduard Fischer, Professor Ludwig Jost, and Professor Emile Topsent.

Mr. J. W. BODGER exhibited a specimen of *Scrophularia vernalis* from Northamptonshire.

Summary and general conclusions regarding the insect fauna of the Seychelles and adjacent islands. By Dr. Hugh Scott.

THE insects collected by the Percy Sladen Trust Expedition to the Indian Ocean under Mr. (now Professor) Stanley Gardiner in 1905 and 1908–9 have all been worked out, and eighty-two systematic reports, by fifty specialists, have been published. As the results of previous collecting have also been taken into account, these conclusions are based on the total fauna known from all the islands.

2,426 species have been enumerated, and 1,423 described as new to science. The problem is not, however, that of a single insular fauna, but of several : on the one hand, the mountainous granitic islands of the Seychelles, standing on a submerged bank some 12,000 square miles in extent, within the 100-fathom line ; on the other, several separate groups

of coral islands (Chagos, Amirantes, Coetivy, Cargados, Farquhar, and the Aldabra group), some standing on shallow submerged banks, others rising separately from great depths. Of the known fauna, 2,090 species are recorded from the Seychelles, 537 from all the coral islands taken together, and only 202 species are common to both the Seychelles and the coral islands. Among the latter, Aldabra and its neighbours have over 300 recorded species, and the Amirantes and Chagos archipelagoes are next, with about 90 species apiece.

The insects of the coral islands, mostly more or less widespread forms, belong to several zoogeographical categories. As might be expected from their situation, the northern and north-eastern archipelagoes (especially the Chagos) have a larger proportion of Indo-Australian species, while the African and Madagascan elements increase as one passes to the south-west, being overwhelmingly strong in the Aldabra group. Nearly all the coral islands, however, possess some species unknown elsewhere. The Aldabra group has twenty-six Coleoptera, and some other insects, believed to be endemic. Otherwise the potential endemics are very few. Excepting, possibly, some curious cases, such as a genus of wingless crickets represented by one species in the mountains of the Seychelles, and another in the Chagos, they are all probably explicable as the descendants of ancestral immigrants which reached the coral islands across the sea.

The Seychelles, on the other hand, have long been considered as not true oceanic islands, but as the remains of a much larger land, possibly directly connected with India and Africa, the latter either through or independently of Madagascar. An attempt is made to test this theory by comparing their fauna with that of a purely oceanic archipelago, for which purpose the volcanic Hawaiian islands are chosen. A comparative table shows the numbers of species and genera of the various orders recorded from the Seychelles and the Hawaiian islands, and the proportion of endemics in each order. A column is added showing the approximate numbers of species for the British Islands, which, situated very close to a continent, and in north-temperate latitudes, offer a strong contrast to the two remote tropical archipelagoes.

Several conclusions emerge on examination of this table. The Seychelles, with a land-area of less than 160 square miles, have 2,090 recorded species, of which over 1,300 are unknown elsewhere; the Hawaiian islands, area about 7,000 square miles, had (when the 'Fauna Hawaiiensis' was completed in 1913) 3,115 species, of which over 2,700 are endemic, a number estimated as about half the existing endemic fauna ;

the British islands, area about 121,000 square miles, have over 20,000 species on a conservative estimate. While the figures show over 80 per cent of the Hawaiian species as endemic, in the Seychelles about 65 per cent are possible endemics, but this percentage will probably be somewhat reduced by the discovery in other countries of some species hitherto unknown elsewhere. As to the proportions of the numbers of species in the different orders, Coleoptera are far the most numerous in both the tropical archipelagoes, a condition which may not be entirely due to the chances of collecting: but in Britain they are heavily outnumbered by both Diptera and Hymenoptera, two orders which are, so far as known, of less antiquity.

Certain orders, such as the palaeontologically very ancient Plecoptera and Mecoptera, are unrepresented in both the tropical archipelagoes. On the other hand, Ephemeroptera and Trichoptera, though quite unrepresented in the Hawaiian islands, have endemic representatives in the Seychelles. The former are believed to extend back to the late Palaeozoic, the latter at least to Jurassic times. Such fragile insects are unlikely to have immigrated over wide stretches of sea, and their presence may be an indication of ancient continental conditions.

A much greater number of families and genera are represented in the Seychelles, both actually and in proportion to the total fauna. The average is less than two species per genus, while in the Hawaiian fauna it is nearer five per genus. The Hawaiian fauna includes numerous 'endemic complexes', i.e. large endemic genera containing many closely related species, a rare phenomenon in the Seychelles. In the Coleoptera alone sixty families are represented in the Seychelles, and forty-five include some endemic species: in the Hawaiian islands only forty-seven families are represented, and the endemic forms are restricted to eighteen families. Only two families are represented in the Hawaiian islands which are unrepresented in the Seychelles, but fifteen families are represented in the Seychelles which have no representative in the Hawaiian islands.

These phenomena appear to indicate that (a) while relatively few ancestral immigrant species have succeeded in crossing the ocean and establishing themselves in the Hawaiian islands, they have given rise to large numbers of descendant species, with a resulting very high percentage of endemism in the fauna: and (b) the Seychelles fauna is the remains of that of an ancient continental or subcontinental land, isolated long enough to have a high percentage of endemic forms, but not so high as in the purely oceanic Hawaiian group.

The endemic fauna of the Seychelles seems to have developed throughout the archipelago as a whole, with little segregation

of distinct forms in the separate islands. The islands may, therefore, have been sundered from each other comparatively recently. The fauna also seems to have been stabilized long ago, with no continuation of species-formation down to recent times, such as has apparently taken place in the Hawaiian archipelago. These conclusions agree closely with those of Summerhayes regarding the flora. The principal change in recent times has, doubtless, been the extermination of many endemic species.

Sections are devoted to local island races of non-endemic species, the reduction or atrophy of wings and eyes in certain species, the smallness and dull colouring (both relative and actual) of most of the endemic insects, and the association of certain members of the fauna and flora. Over seventy species, mostly endemic, and representing twenty-eight families, were found in the spaces between the leaf-axils of endemic palms and *Pandanus*. About one-third of these were not found elsewhere. With other small invertebrates from the same habitat, they probably constitute the longest list of dwellers in leaf-axils from any country in the Old World.

Condensed zoogeographical reviews of the orders are given, and the endemic fauna is analysed. Some few forms appear to be taxonomically isolated, an overwhelmingly large number have Indo-Australian affinities, and others have, respectively, Madagascan, Mascarene, and African affinities (the term 'Mascarene' is restricted to groups centred in the volcanic Mascarene islands and absent from, or weakly represented in, Madagascar). This result, arrived at independently, tallies well with the recently published analysis of the flora. Such a blend is much what might be expected on the hypothesis that the Seychelles are of ancient continental origin. Whether the former land-connexions were 'bridges' in the older sense, or owed their existence and subsequent disappearance to the displacement of the continental land-masses, is a problem beyond the scope of this paper. But assuming the Seychelles to have been connected with Asia and Africa, their isolation must have been brought about very long ago, or they could hardly exhibit so high a degree of endemism in their fauna and flora. There are slight faunistic indications that connexion with Africa may have persisted later than that with Asia, possibly to early Tertiary times, and that the connexion with the two continents need not necessarily have included Madagascar. Suggestions are put forward to explain a puzzling fact, viz., that many of the endemic insects with eastern affinities have their nearest relatives, not in Ceylon and India, but in the Malay Archipelago, or even further south-east, in Australasia and on the confines of the Pacific.

The PRESIDENT having expressed to the author the thanks of the meeting, Professor J. STANLEY GARDINER pointed out that the communication was by far the most important geographical paper, from the point of view of insects, presented since R. C. L. Perkins gave his account of the Hawaiian islands; that the other groups of land-animals support Dr. Scott's view; also, to a lesser degree, plants. Furthermore, as to the coral islands, they are modern, merely 3-5,000 years old, and the most interesting feature is the small number of their insects compared to plants—about equal numbers—whereas one plant should carry on an average six insects.

**Botanical exploration on the Burma-Tibet frontier. (Lecture.)
By Captain F. Kingdon Ward.**

S.E. ASIA from Assam to Annam is a big peninsula almost as much cut off from the rest of Asia as is the Indian peninsula. It differs from the Indian peninsula in one important respect: it has never been completely severed from the mainland of Asia, certainly not in Tertiary time. The southern end of this peninsula has, however, been broken up more than once, giving us the Malay Archipelago. Thus the south-eastern peninsula belongs to Asia even more than the Indian peninsula does, and its past is wrapt up in the past of Asia generally.

A physical map of Asia shows two mountain systems crossing each other, or, perhaps, merely meeting, almost at right-angles. Both are formidable physical barriers, the Himalayan system forming the boundary between the Indo-Malayan and Central Asiatic floral regions, the Sino-Malayan system forming the boundary between the Indo-Malayan and Eastern Asiatic floral regions.

But great mountain systems are also highways of migration. The Himalayan ranges are not only a barrier between north and south, but also a link between east and west. The Sino-Malayan ranges are not only a barrier between east and west, but also a link between north and south. And both together have evolved an alpine flora largely endemic.

In any attempt to unravel the distribution of animals and plants in S.E. Asia two problems present themselves for solution:—

Which of these two mountain systems has had the greater influence on distribution in S.E. Asia generally? (1) In so far as they act as barriers, is the Indo-Malayan region more cut off from the Central Asiatic region, or from the East Asiatic region? (2) In so far as they act as highways, are we to seek an extension of the Himalayan flora to the east, from the Brahmaputra to the Yangtze, thence across China to Japan and Formosa? Or are we to seek it to the south, through

the Malay Peninsula, and thence to the islands of the Malay Archipelago? The facts point to an east-west distribution rather than a north-south distribution, at least so far as the flora is concerned.

This requires explanation, for the facts also point to the Sino-Malayan ranges being much older than the Himalayan ranges; thus the former had a long start, both as barriers and as highways. They existed when the sea covered the plains of India, and much of southern Tibet also, long before the Himalaya were uplifted. In Cretaceous times these Sino-Malayan ranges were merely the west coast of the peninsula, and the only possible line of migration was north and south; nor could the system have been a barrier, since all to the west and north-west was sea, and peninsular India was an island.

Not until Oligocene or Miocene times, after the Himalaya had been uplifted, could there have been any extensive east-west migration, and all our problems of distribution really date from then; that is to say, they are, geologically, modern problems. But whatever may have happened between the Oligocene and the Pleiocene, an event was to take place subsequently to which I think far too little attention has been paid by naturalists. That event was the late Pleistocene glaciation of S.E. Asia. The reason why this has not received the attention it deserves is probably because the glaciated area is a detached one, lying right outside the polar ice-sheet area, to which attention has been mainly directed. Yet during the last maximum advance of the ice, a vast area in the Himalayan and Sino-Malayan mountains, as well as in western China and in Tibet, was covered by ice, and the effects were tremendous.

If we assume, as I think we must, that the Himalayan glaciation was contemporaneous with the Pleistocene glaciation of Europe, then we need not look back more than half a million years to account for all the greater migrations in S.E. Asia; indeed, we need not look back more than about 50,000–100,000 years, to the last great fluctuation. This ice-sheet, which spread over the high mountains of S.E. Asia, had a two-fold effect:—(i) It isolated the entire Indo-Malayan region from the Central Asian, and likewise cut off the East Asiatic region from the Central Asian: though it did not prevent a mingling of East Asiatic and Indo-Malayan forms in the south-east. (ii) It extinguished, or drove southwards, the alpine flora which had already established itself. The southern drive of the flora must have had a telescoping effect, crowding the alpine on to the subalpine, the subalpine on to the warm temperate, and so forth. The return of the flora, as the ice retreated again, must have been a very different

matter. There was ample room now; plant did not compete with plant so much as with external conditions.

In 1932 we reached a point approximately 28° 30' North, 98° 0' East, at the sources of the Irrawaddy, on the Burma-Tibetan frontier. The country explored consists of a series of high rocky ranges, running more or less north and south, separated by deep river-gorges: the whole covered with forest to a height of about 12,000 ft. Above 12,000 ft. there is only thick scrub, and above that again, between 13,000 and 14,000 ft., dwarf scrub and scattered alpine plants.

The forest belt may be conveniently divided into (i) sub-tropical jungle, up to 3,000 ft.; (ii) hill jungle, 3,000 to 6,000 ft. away from the neighbourhood of the snowy ranges; (iii) temperate rain forest, 5,000 to 8,000 ft., close to the snowy ranges; (iv) Conifer-Rhododendron forest, 8,000 to 10,000 ft.; (v) *Abies* forest up to 12,000 ft.

In the hill jungle occur several species of *Begonia* showing affinity with Malayan species, also a *Cypripedium* related to *C. Argus*, a Phillippine Island species.

In the temperate rain forest about a third or a quarter of the tree species are deciduous. The affinity is rather with the Himalaya and China. Unexpected discoveries were *Cercidiphyllum japonicum* and *Stachyurus praecox*, known from Japan and central China, and *Pentaptyxis stipulacea*, known from Sikkim. There are numerous species of *Rhododendron* and other Ericaceae, Lauraceae, Araliaceae, Rosaceae, and Magnoliaceae; species of *Acer*, *Quercus*, *Ilex*, and *Salix*. The Conifer-Rhododendron belt is mainly evergreen, consisting largely of *Pinus excelsa*, *Tsuga Brunoniana*, *Picea Morinda*, and *Larix tibetica*; species of *Ilex* and evergreen Oak; and several species of *Acer*. The Rhododendrons grow socially, often forming forests almost by themselves. The Sikkim *Magnolia globosa* grows here.

In the alpine zone the affinity is very distinctly with the Himalayan and Chinese ranges to east and west; and, in so far as species are endemic, they are endemic on the Sino-Himalayan and Sino-Malayan ranges, considered as one plant area.

The most prolific genera are *Rhododendron* and *Primula*, *Pedicularis*, *Saxifraga*, *Polygonum*, and the endemic genus *Cremanthodium*. Typical northern temperate families, such as Ranunculaceae, abound not only in genera, but in species and individuals; and the universally successful Compositae are represented by incredible numbers, representing a large number of genera and species. The endemic genus *Nomocharis* is represented by two or three species of restricted range, and one—*N. nana*—which ranges throughout the area. There are half a dozen species of *Meconopsis*, a genus almost

completely confined to Sino-Himalaya, one species being locally endemic. *Gentiana*, *Cyananthus*, *Impatiens*, *Corydalis*, *Potentilla*, *Allium*, are all well represented.

Mr. I. H. BURKILL asked if Captain Kingdon Ward had not observed more distinct signs of the wearing out of the south-west monsoon in his Rima exploration of 1928 than in his new exploration, saying that the beautiful pictures of vegetation thrown upon the screen suggested this.

Captain KINGDON WARD replied that he did not think so.

A vote of thanks to Captain Kingdon Ward was conveyed by the President.

The following paper was read in title :—

‘Reports of an Expedition to Paraguay and Brazil in 1926–7, supported by the Trustees of the Percy Sladen Memorial Fund and the Executive Committee of the Carnegie Trust for the Universities of Scotland. Arachnida from the Paraguayan Chaco.’ By H. D. BADCOCK, M.A. Oxon, F.Z.S.

24 MAY 1932

Anniversary Meeting

Professor F. E. WEISS, F.R.S., President,
in the Chair

The Proceedings of the previous meeting, held on Thursday, 12 May 1932, having been circulated, were taken as read and confirmed.

A list of names of those who had made gifts to the Library since the previous meeting was read and laid on the table. A special vote of thanks was accorded to the Rev. Canon G. R. Bullock-Webster for the donation of a valuable collection of pamphlets on the Characeae.

The following Fellows signed the Obligation in the Book of the Charter and Bye-Laws and were admitted :—Benjamin Peary Pal and William Borlase.

Certificates of recommendation of the following candidates for Fellowship were read :—For the second time, in favour of Irene Alexandra Francis Hilton, Kurumthottical Cherian Jacob, and Thomas Kenneth Rees ; for the first time, in favour of Mohamed Eweis.

The following candidates were balloted for and elected Fellows :—Raghunath Prasad Asthana and Abdus Sattar.

The Treasurer presented his Financial Report and the Accounts of the Society, duly audited, for the year 1931-2. On a motion by Professor W. Garstang, seconded by Mr. H. N. Ridley, the Report and Statement of Accounts were adopted.

The Bye-Laws regulating the Election of Council and Officers having been read by the Assistant Secretary, the PRESIDENT declared the Ballot for Council and Officers to be open, and voting began. The Ballot for Council was closed at 5.30 p.m. and for Officers at 6.0 p.m.

Meanwhile the Librarian and Assistant-Secretary presented his Report as follows :—

LIST OF THE SOCIETY.—Since the last Anniversary Meeting the Society has lost forty-four members. The detailed statement is as follows :—

15 Fellows by death :—José de Campos Novaes, Thomas Ford Chipp, George Claridge Druce, Percy Groom, Charles Osborne Smeathman Hatton, James John Joicey, Robert Patterson, Henry William Potts, Joan Beauchamp Procter, George Michael Ryan, John Donnell Smith, Sir William Somerville, Edward Step, John Henry Tull Walsh, Herbert Bennett Williamson.

1 Associate by death:—Andrew Scott.

3 Foreign Members by death:—John Isaac Briquet, Hans Oscar Juel, Richard Wettstein von Westersheim.

16 Fellows by Withdrawal:—Rakhal Das Bose, Sahay Ram Bose, Ernest Brown, Henry James Davies, Charles Cuthbert Eley, Charles Ethelbert Foweraker, Grace Frankland, Alice Hibbert-Ware, Cecil Henry Hooper, Lilian Mary Joy, Valavanur Subramania Kuppuswamy, James Eustace Radclyffe McDonagh, Henry Goland Robinson, Lekshminarayanapuram Subramania Subramaniam, Jacques de Vilmorin, Evelyn Janie Welsford.

9 Fellows by Removal:—Richard Siddoway Bagnall, Francis Boothroyd, Joseph Calvert, John Clark, Frank Cornish, Basant Lal Gupta, Manaranjan Mitra, Eugenie Sachs, Walter Sidney Stevens.

During the Session 4 Foreign Members and 31 Fellows have been elected. Of the 31 Fellows elected, 25 have qualified. Also 8 Fellows have qualified who were elected at the end of last Session.

The present number on the List of Fellows is 757, with 8 Fellows elected but not yet qualified.

Between 1 May 1931 and 30 April 1932 the increased cost of a large number of the serial and periodical publications has restricted the purchase of new books to one half-dozen, but several authors have generously helped the Library by the presentation of their recent works. In all, 157 books and pamphlets were presented.

During the same period 1,054 volumes were borrowed by 177 Fellows and Associates. In addition, the National Central Library borrowed 237 volumes. On the other hand, the Society borrowed on behalf of Fellows and Associates 7 volumes from the Science Library and 7 volumes through the National Central Library.

984 signatures were recorded in the Library Visitors' Book, exclusive of 80 on Saturday afternoons.

At the conclusion of the Assistant-Secretary's report, the PRESIDENT appointed Mr. H. N. Ridley, Mr. D. J. Scourfield, and Mr. A. W. Sheppard as Scrutineers of the Ballot.

The PRESIDENT then called upon Professor E. S. GOODRICH, M.A., LL.D., F.R.S., who had been selected as the recipient of the Linnean Gold Medal, and addressed him in the following words :—

EDWIN STEPHEN GOODRICH: It gives me personally particular pleasure to hand you the Linnean Medal, as it recalls to my memory the days when, like you, I was a student of Zoology at University College under that inspiring teacher Sir Edwin Ray Lankester, himself a recipient of the Linnean Medal in 1925. You are a worthy successor of our great master. You followed him to Oxford as Aldrichian Demonstrator, and succeeded to his successor, Professor G. C. Bourne, in the Linacre Professorship of Zoology and Comparative Anatomy.

Your investigations into the excretory organs of the Invertebrates established the true nature of the nephridia and their distinctive difference from the 'coelomoducts'. These researches were not only in themselves of fundamental importance, but they have inspired both some of your pupils and workers in other countries to continue these investigations along further and fruitful lines.

Your morphological work on the structure of fishes culminated in the publication of the 'Treatise on Fishes' in Lankester's 'System of Zoology', a volume which will long continue to be appreciated by all students of Zoology. Your other morphological investigations into the vascular and coelomic systems, particularly in the group of Annelids, have led to most interesting and striking results.

These, and the other researches I have referred to, have been carried out with skill and perseverance during a busy teaching career, and in spite of many interruptions which the administration of a flourishing university department have necessarily entailed. Nor have these detailed investigations restricted your general outlook on Zoological Science, as your delightful volume on 'Living Organisms', with its many aspects of interest, clearly shows. Your more recently published 'Comparative Anatomy of Vertebrates', which will long remain a standard among advanced text-books, is a fitting memorial of a long and fruitful career as a teacher.

It is no wonder then that you were selected as editor-in-chief of the 'Quarterly Journal of Microscopical Science', that premier journal of comparative morphology in the English language, and the twelve years which have elapsed since your appointment have shown how worthily you have carried on its great tradition.

With such a record of scientific activities we feel there could be no more worthy recipient of the Linnean Medal, and in awarding it to you as we do for the great services you have rendered to Zoological Science, we remember at the same time, with gratitude, the invaluable help you have given to this Society as its indefatigable Zoological Secretary for a period of eight years.

In reply, Professor GOODRICH expressed his profound appreciation of the honour that had been conferred upon him.

In the introductory passage to his Address, the PRESIDENT made the following statements :—

The Assistant Secretary has already read the list, alas! too long, of Fellows who have died since the last Anniversary Meeting. Obituary notices of these will be included in the 'Proceedings'. But I cannot refrain from a personal reference to two or three whose loss we shall feel particularly keenly.

By the untimely and unexpected death of Major Thomas Ford Chipp, Assistant Director of the Royal Gardens, Kew, British Botany has lost a valuable and promising worker whom it could ill spare, and the Linnean Society an active and esteemed Fellow, who last session was serving on its Council, where he had gained the esteem and affection of his fellow members.

Dr. George Claridge Druce, by contrast, was a Nestor among botanists, and his death removes from our midst one who will long be remembered as one of the most kindly and helpful of systematists, always ready in his courteous way to give information and enlightenment in difficult points of discrimination of species and their varieties. Through the

Botanical Exchange Club he was, no doubt, in touch with most of the collectors of British plants, and ever ready to assist them. He was elected a Fellow in 1879, so that he was one of the oldest Fellows of the Society.

Through the death of Lieut.-Col. Tull Walsh the Society has lost one of the most regular attenders at its meetings, and one for whom all who were brought in contact with him must have had the greatest admiration. Though handicapped of late in his activities by a painful infirmity, I have never known him to complain, nor found him other than cheerful; and in taking his part in the proceedings and in the life of the Linnean Club he has set us an example which it will be difficult to follow. We shall not easily forget so admirable and lovable a nature.

Of the three Foreign Members whom we have lost, only one, John Isaac Briquet, was known to me personally, and I little thought when he assisted me last year in Geneva in some difficult identifications that we should be mourning his loss this summer. Apart from his contributions to science, he will be remembered as the active and energetic Rapporteur général in connection with the section of Nomenclature of successive International Botanical Congresses. In this capacity he rendered yeoman service to botanists of all nationalities, and his kindly personality will be remembered by all who were brought into contact with him.

Though we have lost three eminent foreign botanists during the past session, I am glad to think that the Society has made good these serious losses by the election as Foreign Members of Prof. Klas Elias Fries, of Stockholm, Eduard Fischer, of Bern, and Ludwig Jost, of Heidelberg. In addition, we have elected M. Emile Topsent, the distinguished zoologist, of Strasbourg.

I ought, perhaps, to refer also to the addition to our slender list of Honorary Members of His Imperial Majesty the Emperor of Japan, one of the few rulers of an empire genuinely interested in its Natural History, and who maintains in Japan his private botanical garden and laboratory.

Our remembrance of a former distinguished Fellow of the Society, Robert Brown, who for a long period of years acted as Librarian, and subsequently became Vice-President and President of the Society, was revived by our celebration in November of his discovery of the nucleus in the vegetable cell, a discovery which opened up a new and important chapter in the history of the anatomy of both plants and animals. A full account of this very interesting commemoration has been published in the 'Proceedings' of the Society.

The Treasurer's statement will have revealed to you that the Society has passed through a somewhat difficult financial period. Not only had we to pay for considerable and expensive

electricity alterations, but, owing to the depreciation of the pound, we had a considerable increase of financial liabilities in connexion with the necessary continued purchase of foreign periodicals. This has greatly restricted the money available for the purchase of new and important books, and we have had to rely largely, as the Librarian has already stated, upon the generous donations of books from Fellows and other friends of the Society. I trust that we shall be able next year to make good some of the deficiencies which have necessarily arisen. I am pleased to be able to announce that our Treasurer, Mr. Francis Druce, has made a generous donation to the Society for the purchase of books next year. Let us hope that his good example may be followed by other Fellows.

A few years ago we received generous assistance towards the expenses of the library from the Carnegie Trustees, for which we were, and are, very grateful, but, unfortunately, they were unable to continue their financial aid during the past session. We undertook, in return for their generous grant, to become an 'Outlier Library' under their scheme, and to loan books to non-members of our Society through the National Central Library. It may be of interest to you to know that we have carried out this undertaking with considerable success from the point of view of the scheme, as there has been a continuous and growing demand for books from our library. The number borrowed during the last five years has been as follows :—

1927-28	.....	53 volumes
1928-29	.....	62 "
1929-30	.....	136 "
1930-31	.....	190 "
1931-32	.....	237 "

In return, as the Librarian has stated, some of our Fellows have been able to obtain books we did not possess through the National Central Library. To carry out the obligations of an Outlier Library it is essential that we should bind up, without too much delay, the periodicals of the past year, as only bound volumes can be lent. Unfortunately, owing to financial stringency, we have dropped behind this session, and a considerable sum will be required in the next financial year for the necessary binding.

We have, as you will have seen from the balance sheet, some funds in hand, though not quite as much as this time last year, but these funds will be swallowed up by the cost of our publications, and these we are anxious to keep up in a high state of efficiency, not only for the benefit of our Fellows, and particularly of those who cannot, by reason of distance,

attend our meetings, but also because they are essential to us as a medium of exchange with other societies whose publications we desire to possess.

It may be of interest to you to know that your Council has decided to publish a series of important papers resulting from the Cambridge Expedition, led by Dr. E. B. Worthington, to the East African lakes.

As many of you know, your Council had offered to it, for purchase, a portrait of our former Foreign Member, Prof. Julius Sachs, painted by his daughter, an artist in Munich. Unfortunately, the Council, though desirous of possessing this portrait of one of our most distinguished Foreign Members, had no funds available for the purpose. I was asked, therefore, to endeavour to obtain from individual Fellows, by kindly persuasion, the necessary sum. I am glad to be able to report that the confidence of the Council in the generosity of the Fellows was not misplaced, and, with certain outstanding promises, the sum required for the purchase is now in hand, and I hope that at the commencement of next session, when we celebrate the Centenary of Sachs's birth, we shall be able to instal his portrait in our Rooms.

The PRESIDENT then delivered his Address on 'A re-examination of the Stigmarian problem'. On its conclusion, Dr. D. H. SCOTT, F.R.S., moved 'That the President be thanked for his excellent Address, and that he be requested to allow it to be printed and circulated amongst the Fellows' (see pp. 155-166). The motion was seconded by Sir SIDNEY F. HARMER, K.B.E., F.R.S., and being put to the meeting was carried with acclamation.

The Scrutineers of the Ballot, who had retired at the appointed times with the voting lists for the election of the Council and of the Officers, having completed their scrutiny, reported to the President, and he declared the result as follows:—

COUNCIL FOR 1932-3. — Dr. W. T. Calman, F.R.S.; Dr. G. S. Carter; Dr. S. E. Chandler; Mr. Francis Druce; Dr. Philippa C. Esdaile; Professor J. Stanley Gardiner, F.R.S.; Professor T. G. Hill; Professor H. S. Holden; Professor W. Neilson Jones; Mr. N. B. Kinnear; Mr. G. W. E. Loder; Professor E. W. MacBride, F.R.S.; Professor J. R. Matthews; Mr. J. R. Norman; Mr. John Ramsbottom, O.B.E.; Lt.-Col. J. Stephenson, C.I.E., F.R.S.; Dr. H. Hamshaw Thomas, M.B.E.; Miss E. M. Wakefield; Professor F. E. Weiss, F.R.S.; Mr. A. J. Wilmott.

(The retiring Councillors were Dr. G. P. Bidder, Mr. I. H. Burkill, Mr. G. R. de Beer, Professor R. R. Gates, F.R.S., and Sir Sidney F. Harmer, K.B.E., F.R.S.)

OFFICERS FOR 1932-3. — *President*: Professor Frederick Ernest Weiss, F.R.S.; *Treasurer*: Mr. Francis Druce; *Botanical Secretary*: Mr. John Ramsbottom, O.B.E.; *Zoological Secretary*: Lt.-Col. John Stephenson, C.I.E., F.R.S.

The PRESIDENT announced that he had appointed the following as VICE-PRESIDENTS for 1932-3:—Mr. Francis Druce, Dr. Philippa C. Esdaile, Professor J. Stanley Gardiner, F.R.S., and Professor T. G. Hill.

The PRESIDENT then declared the Session of 1931-2 closed.

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PROCEEDINGS OF
THE LINNEAN SOCIETY OF LONDON

Session 1931-32

PART II (pp. 17-56)

CONTAINING ACCOUNT OF THE CENTENARY CELE-
BRATION OF ROBERT BROWN'S DISCOVERY OF
THE NUCLEUS OF THE VEGETABLE CELL.

NOTICE

Non-Fellows may obtain the Proceedings for the current year,
including each part for the Session as published, by prepayment
of 10s. 6d. post-free.

THE LINNEAN SOCIETY OF LONDON.

LIST OF OFFICERS AND COUNCIL.

1932-33.

PRESIDENT.

Professor Frederick Ernest Weiss, F.R.S.

VICE-PRESIDENTS.

Mr. Francis Druce.
Dr. Philippa C. Esdaile.

Prof. J. Stanley Gardiner, F.R.S.
Prof. T. G. Hill.

TREASURER.

Mr. Francis Druce.

SECRETARIES.

Botanical.

Mr. John Ramsbottom, O.B.E.

Zoological.

| Lt.-Col. J. Stephenson, C.I.E., F.R.S.

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Mr. N. B. Kinnear.

Mr. G. W. E. Loder.
Prof. E. W. MacBride, F.R.S.
Prof. J. R. Matthews.
Mr. J. R. Norman.
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Dr. H. Hamshaw Thomas, M.B.E.
Miss E. M. Wakefield.
Prof. F. E. Weiss, F.R.S.
Mr. A. J. Wilmott.

LIBRARIAN AND ASSISTANT SECRETARY.

Mr. Spencer Savage.

